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The Rate Decision

TIME only can tell just what will be the effect of the rate decision. Certainly the Interstate Commerce Commission has granted the Eastern railroads something—which is more than it could do four years ago, or even last summer for the lines east of Buffalo and Pittsburgh—and has done so with comparative alacrity. The effect will presumably be more psychological than financial. Railroad men realize that the money involved is inadequate; the entire amount has been absorbed in advance—by increased wages since the first application four years ago. Optimists, however, believe that the decision is an indication of a turn in public sentiment, and a growing belief that the railroads really do need and deserve help, as their managers have insistently claimed. Further evidence of this change in the popular idea they find in President Wilson's attitude toward the railroads, in the repeal by popular vote of the Missouri full-crew law and in the leadership assumed by the New Jersey Chamber of Commerce in the fight for the repeal of the same obnoxious law in that State. If the railroads now find it possible to market their securities on reasonable terms and thus raise the money to pay for needed improvements, as they have in general been unable to do of late, it will be because of the investor's belief in this change of public sentiment rather than the $25,000,000 or so actually obtainable by the increased rates.

Camping "de Luxe"

SELDOM have engineers in the field, especially on work that kept them constantly moving, had as much attention given their personal comfort as the United States Government is giving to the large roadway parties on the railway valuation work. On preliminary or location surveys, hardships and privation have been looked upon as necessary incidents, and men who could not do without porcelain bath tubs and fancy cooking have been regarded as mollycoddles unfit for the work. Even the parties that follow in the wake of civilization, such as the permanent railroad engineering corps, are accustomed to getting along with whatever is obtainable in the way of hotels or boarding houses. On page 696 is an account of the "accommodations de luxe" for the roadway parties of the Western District of the Government Division of Valuation. Uncle Sam is able to provide such quarters economically because the parties are large enough to fill a Pullman car. In this work especially provision of proper living conditions would seem to be a longsighted policy. This journal has already expressed doubt as to the feasibility of getting uniformly usable data for this great undertaking. Surely the most likely means of getting suitable notes is by offering the men sufficient inducement to stay and become trained to the work.

Buried Wealth

IN litigation involving such large interests as those of the States of New York and New Jersey in their controversy over the discharge of sewage into New York harbor from the Passaic Valley a vast amount of technical data is always collected. In the present case, which is now before the Supreme Court of the United States, sanitary experts of international reputation have, at the instance of Dr. William J. O'Sullivan, special counsel for the State of New York, testified and submitted voluminous reports. In fact, special trips to Europe have been made to secure at first hand information needed in the preparation of the case. While all this material relates primarily to the specific problem of New York harbor it has a wide application to conditions elsewhere. It is reasonable to infer that engineers throughout the country would appreciate an opportunity of securing copies of the various technical reports, and yet this seems impossible, for it is proposed to print only enough copies for the use of the court and counsel. In fact the material is now in the hands of the Government printer at Washington. Many thousands of dollars have been spent in securing the information and it would be a pity if what amounts almost to an encyclopædia of the subject of harbor pollution were not given the widest publicity. There is an opportunity for the Board of Estimate and Apportionment or the Merchants' Association of New York, by providing funds for printing extra copies of the testimony and reports, to do a great service to the engineering profession.

Neglecting the Bridges

COMMENT has already been made in the pages of this journal on the campaign waged by the "Service Bulletin" of the Iowa Highway Commission to lessen accidents at grade crossings and to eliminate weak, and therefore dangerous, bridges. Exceptionally pointed treatment of these subjects is found in a recent issue. A series of descriptions of the accidents responsible for twenty-one road fatalities is prefaced by a strongly worded appeal from the commission, asking a saner use of the roads, the while safe bridges and culverts are being built and dangerous grades, curves and crossings eliminated. There is a lesson in the conditions disclosed, not alone for Iowa but for other communities. Many States have a large number of inferior bridges, both wood and steel, on highways now being resurfaced. It is natural to postpone the expenditure necessary to replace them adequately, until the new surfacing, more prominent evidence of administrative activity, is completed. Frequent accidents such as those in Iowa prove the need for taking radical steps to change this policy. From the point of view of safety alone it would be wise to improve no road until every bridge on it was put in proper condition, for smooth, metaled roadways and weak, poorly maintained bridges form a dangerous combination. Where a commission has little control over bridges the condition is of course even more serious. It need not be said that the course suggested would not be practicable in every instance, but it should serve as an ideal for road officials charged with the responsibility of providing safe traffic arteries for large populations.

Winter Operation of Stoney Gates

THE experiences with Stoney gates at a Canadian dam last winter, described on page 691, are worthy of the attention of every hydraulic engineer. A comparison with the experiences with rolling dams in Europe under about the same winter conditions (see Engineering Record of May 30, 1914, page 618,) is not without interest. The dam of the Shawinigan Water & Power Company is located at about the forty-eighth degree of latitude, while the Tröllhattan plant in Sweden is somewhat above the forty-eighth, and the Ensokoski plant in Finland close to the sixty-first degree. In spite of this the winter climate is about the same, thus making fair a comparison between the plants. In Canada it took the operators eight hours before the gate was thawed out, although every precaution to facilitate winter operation had been taken. At Tröllhattan, where there were no such precautions, the task of thawing out a gate had to be given up after two days' hard work. The rolling dams, however, could easily have been kept in operating condition by placing coal stoves in each end of the roller. At Ensokoski, where rolling dams are also in use, it seemed as if it would be impossible to operate the dam, but after two hours' work with steam and crowbars, during which time the roller was kept heated by coal stoves placed inside, the dam was in operating condition. When the Stoney gate was finally raised at Shawinigan the ice barrier, formed in front of the gate, was so strong that it withstood ing stresses in the ice might have developed, the span been short—it was 40 ft.—arching stresses in the ice might have developed, thus necessitating the use of dynamite before the opening was cleared. It is of interest to note that if the backs of steel gates are enclosed by wooden sheathing, the thickness of the ice formed in front of the skin plate is 50 per cent less than if no such sheathing is used. The experiences with winter operation that the Engineering Record has published are food for serious thought, and show clearly that the more expensive installations may be the cheaper in the long run, and that the construction permitting the longest spans has certain advantages over other types.

Evening Instruction for New York City's Engineers

PREPARATIONS have just been completed for offering to engineers and engineering assistants in the employ of New York City evening-class instruction in engineering and allied subjects. Mayor Mitchel and his administration have planned to make available to municipal employees opportunities for special instruction similar to those which for several years have been open to employees of business houses through the Extra-Mural Division of New York University. Classes for clerical employees were started in the fall. To make ready for the engineering courses has involved much more labor, but according to the bulletin of the university these classes are expected to begin with the new year. Twenty-four courses have been prepared by an advisory committee of eight engineers, seven of whom are in prominent positions on the city's technical staff, coöperating with the university authorities. Written and oral English, mathematics, mechanics, drawing, surveying, designing, inspecting, legal and engineering features of municipal contracts, and many of the specialized branches of engineering practice involved in the city's diversified public works are covered. For the fundamental or preparatory courses the instructors are drawn chiefly from the teaching staff of the university; for the remainder engineers in active practice have been chosen, most of them from the city's corps.

To enrich the courses a large number of engineers who have achieved distinction in the profession have been induced to contribute lectures based on their experiences and dealing with special features of municipal work. It is intended that these lectures will be open to others than the members of the classes in connection with which they will be given. In this way some benefit of the courses will reach many of the city's engineers who cannot take advantage of the class-room work. It is evident, therefore, that those who have planned these courses endeavored to afford not only opportunities for engineers in the city's employ to increase their knowledge of their specialties, but also means for those who will to broaden their view of the engineering field and to improve their powers of expression. Achievement will be measured, to be sure, largely by the spirit and heartiness with which those for whom these opportunities have been prepared take advantage of them, and the wisdom with which the courses are maintained, improved and extended from year to year.

New York's efforts to increase the fitness of its employees may well be emulated by other communities, each in a way adapted to the local needs and resources. Such attempts in private and public organizations to increase individual and collective efficiency are among the hopeful signs of the day. The Engineering Record believes that these projects will have wide-reaching although not spectacular results and will benefit not only the class members but also the instructors, the lecturers and the sponsors. The thoroughness of the preparation in this case is to be commended. Appreciation should be prompt and generous on the part of those for whom the thought and time has been expended.

Such the Reward of Virtue

UNSCRUPULOUS schemers, as the readers of the Engineering Record know, have for the past two years or more been operating in different parts of the country, endeavoring to have engineers invest money as a condition of employment in engineering companies. These organizations have turned out to be merely means for fleecing the unsuspecting.

Having had its attention called to this practice and having unwittingly accepted an advertisement from one of them several years ago, the Engineering Record established it as a policy to investigate carefully the standing of those who wished to advertise for employees and stipulated that they must invest a certain amount of money. Invariably heretofore legitimate advertisers have responded promptly to requests for references. That all do not appreciate the Engineering Record's object is evident from a communication received last week. It came from an engineer who desired to advertise for an assistant able to invest a certain sum of money. The usual letter was written, asking for references and for particulars as to the position. Here is the reply:

"Replying to yours of the 25th will request that you return my check to me at once. I am not Looking for an Engineer who is not able to manage his own Business. and your letter indicates that it is necessary for you to act as Guardian for the readers of your Paper. and I am not willing to become at this time associated with that class of men. Should I desire in the future to attempt to form association with men not capable of handling their own affairs I will be Sure to send you another add. check and the information so wisely sought by you."

Lest this ironical arraignment should fail to impress the Engineering Record with the puerility of its procedure, the following postscript, calculated to instill in its staff a proper fear, is added:

"If you have had any reports on me that is not considered the right thing, it would be wise for you to get my side of the question for otherwise I may Decide to give your letter world-wide Publication for the Benefit of the Engineers."

Such the reward of virtue.

Selection of High-Power High-Speed Water Wheels

FEW lines of engineering have made such rapid advances during the past seven years as water-wheel design. The old way of selecting a "suitable" wheel from stock sizes, so that it would fit a generator taken from the stock sizes of another concern, is now followed only for very small plants. For all other developments plans are submitted to manufacturers, who design turbines especially for the given plant.

From a line of tested model runners the designer is able to select the one whose characteristics are most suitable for the development in question. As the power required per unit and the average head are given by the builder of the plant, the designer has only to figure the required diameter of the runner under the particular conditions. Given the revolutions per minute of the runner shaft and the power required, the generator builder readily designs his part of the installation. Thus, the most important part of the design is the selection of the runner whose characteristics are most suitable.

These required characteristics depend upon the conditions under which the plant will be operated. If there are so many wheels that they can be run most of the time at the gate opening which gives maximum efficiency, and the load fluctuation is taken care of by one unit, the inefficiency of that wheel is only a small fraction of the total efficiency of the plant. Therefore a wheel with a sharp-peaked characteristic is permissible. If only a few, low-power units are installed, a high maximum efficiency is less important than a flat efficiency curve giving comparatively high values for all gate openings within certain limits.

As the reports from the Holyoke testing flume consist of a table only, the designer of the runner must plot diagrams, so as to show graphically the characteristics of the wheel, for only from such diagrams can the characteristics be fully appreciated. In the article on page 585 of the Engineering Record of Nov. 28, Professor Zowski, of the University of Michigan, has shown such curves, which present in a clear, concise manner some recent tests of high-power, high-specific-speed runners. These features, high power and high speed, are now more important than ever, for in most low-head plants the multiple-runner wheel, with its rapidly revolving shaft, has been replaced by the single runner type. The model runner 1796, referred to in Professor Zowski's article, served as a basis for the design of some of the water wheels now in use at Keokuk, which when tested in place gave an efficiency of 91 per cent.

In this issue, page 689, will be found a supplementary article by Professor Zowski, dealing with two recent tests, wheels 2359 and 2363. Wheel 2359 is of special interest as the unprecedented efficiency of 93 per cent was obtained. Previously the highest efficiency of a water-wheel model was 91.27 per cent (see Engineering Record, June

20, 1914, page 701.) As is well known the conditions at Holyoke under which models of this capacity are tested are not of the best. The discharge pit under the turbine is quite limited and the head-water enters the penstock in a manner far from satisfactory and not in conformity with good hydraulic engineering practice. The larger the size of the model the greater the influence of these disadvantages, and the manufacturer, or designer, in order that he may compare more correctly the test results of his runners, generally builds his models of the same size. One firm uses 28 in., another 30 in., etc. As test runner 2359 is 35 in. in diameter, it can be expected, according to the formula of Camerer, to have given a slightly higher efficiency than had the same wheel been built with a diameter of 28 in., but the larger drafttube losses at Holyoke for the bigger runner may have more than overbalanced this advantage.

It has been shown in a carefully conducted test that a runner developing 89.7 per cent maximum efficiency at Holyoke, when built on a scale three times as large and installed under a head of 47 ft., developed a maximum efficiency of 93.7 per cent, which of course is the efficiency of the turbine only and not the hydraulic efficiency of the plant. It is, therefore, to be expected that wheel 2359, when built in larger sizes and installed under higher heads, will develop at least 95 per cent efficiency, and possibly even as high as 96 per cent.

How Shall Provision Be Made for Subsurface Structures?

PAVEMENT cutting has rightly been given a large amount of attention. Some progress has been made, chiefly in adopting the rule that all utilities must make repairs, lay additional mains or alter their systems before new pavements are constructed. Ample time is given them for the work previous to surfacing, and after completion of the job, permits for pavement cuts are denied for periods of four or five years.

This rule is a material advance over the former unregulated procedure, under which permission for cuts could be secured within a few days after the new street was open to traffic. Municipal engineers, however, have felt that even with these restrictions, there was much to be desired—that cutting was decidedly objectionable in a good pavement no matter what its age. Many have, therefore, fondly harbored the idea that some day all, or almost all, subsurface utility structures would be housed in substantial pipe galleries. This proposed solution has been advocated quite often by those who have not studied the problem in detail —in fact the less the study, the more decided the views in favor of the subways. The advantages, apparently at least, are great.

Recently Chicago has been interesting itself in the subsurface-structure problem and the Chicago Committee on Downtown Municipal Improvements sent its secretary-engineer abroad to study European experiences. His conclusions will be found on page 705. It is apparent that Mr. Dumond's studies, when combined with his knowledge of American conditions, have not made him an enthusiast for pipe subways. He foresees many difficulties, and though nowhere in his summary can be found an explicit and unqualified statement of his position, one can form the conclusion for him that, under Chicago's conditions at least, one had better look in other directions for a solution.

And such, in the Engineering Record's judgment, will be the decision in other cities in this country. In the first place, the design of pipe galleries is not so simple a matter as would at first appear. They are not merely box sections with sides, top and bottom, offering no other problem than provision for the earth and traffic loads. Openings of sufficient size for introducing lengths of pipe are necessary, while the handling of heavy sections in the gallery itself—their transportation and placement —require special equipment and arrangements.

Furthermore, there are limitations surrounding some of the utilities that make it impossible to put all of them in a single gallery. Gas mains, it is generally agreed, should be segregated, while no one wants to place his structures in the same enclosure with a high-pressure water main. The latter has been demonstrated in the Centre Street loop subway, New York, where the high-pressure line is in solitary possession of the pipe gallery.

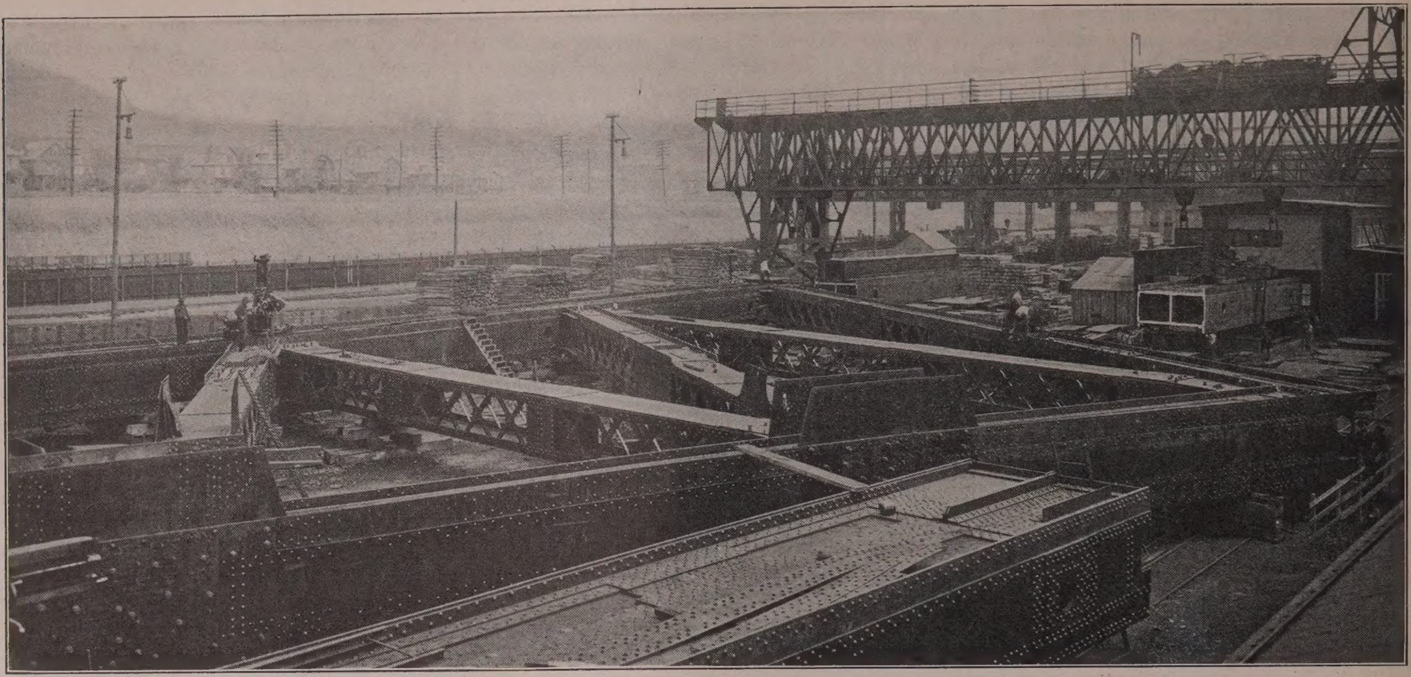
These are technical difficulties only. Legal and financial considerations are no less unfavorable to the pipe gallery. It is questionable whether existing utilities can be forced into the gallery, particularly if they must pay large rentals. The chief obstacle, however, is financial, especially when considered in relation to the chief purpose of the subway—to prevent the tearing up of the pavement. Studies made by a New York Commission about four years ago showed that the cost of galleries was such that instead of building them the community could afford to repave the streets (with asphalt) every two and a half years. Of course, the natural thought is that the utility should be made to bear some part of the expense and thus relieve the community of it, but against such a proposal is the unlikelihood of being able to force the companies to use the structure.

Nevertheless it is patent that some method other than the one now common, of placing all subsurface structures beneath a street pavement is needed. Mr. Dumond has referred to one of them, the use of subsidewalk space in his conclusions, and experience abroad certainly favors it as against the pipe gallery. Those not familiar with European experience are under the impression that pipe subways are quite common there. Such is not the case. The sewers of Paris have been used for this purpose, but the only place where there is considerable sentiment in favor of the plan is in England. Germany almost universally, and to some extent France, is using, the subsidewalk space, and in its utilization lies, in the judgment of the Engineering Record, the future solution of the problem. There is a possibility that in some cities the municipality is not in control of this area and such, it appears from Mr. Dumond's conclusions, may be the case in Chicago. In the greater portion of New York City, however, it has been conclusively established that the city owns the street from property line to property line and that subsurface space now utilized by abutting property owners is on easement only. The city may, therefore, at any time dispossess the vault user, and such is done regularly when new subways lines must encroach on the subsidewalk space.

In New York the step has already been taken of utilizing parking strips for the service mains, and the bureaus in charge of subsurface structures are now at work on designs for utilizing the sidewalk area. It is not proposed to use this space for the trunk lines. They may still very properly be placed under the street, since disturbances of the surface are caused but seldom by the main arteries. Cuts usually are necessary for making or repairing connections to abutting property, and all lines in such use—service mains—should be in the subsidewalk space. Here, it is true, disturbance will be necessary, but it is much easier and much cheaper to tear up a sidewalk than a street, while the resulting inconvenience is much less.

In connection with these plans New York is also taking heroic measures in connection with existing structures. While the rule enunciated in the first paragraph has long been enforced in the city, the authorities have now gone a step farther and before a street is repaved every company and department having a utility in the street must go over its entire system, examining each joint and putting it in first-class condition if defective. Furthermore, services that are troublesome and no longer needed are cut out, and at the present time the Department of Water Supply, Gas & Electricity has under way a considerable contract in lower New York for cutting out of service entirely an old system of water mains, superseded some years ago by a later service. The old pipes had been kept in commission and breaks at connections had been the cause of frequent surface disturbance. Then, as franchises for some of the utilities expire, as for instance those of the gas companies, the franchises are not to be renewed and the mains covered by the permit are to be cut out of service. In some streets there are as many as a dozen different gas pipes, each laid under a separate franchise.

As already stated, the subject is important for all municipalities and the advantages offered by the subsidewalk space for service mains are so great that the Engineering Record expects to see a decided increase in its use in the near future. The progress made in New York will be worth watching, while the courageous stand of the municipal officials with reference to old and troublesome lines cannot be too highly commended.



ASSEMBLING THE HELL GATE ARCH TRUSSES IN FOUR-PANEL SECTIONS IN THE BRIDGE-SHOP YARD

Fabricating Steelwork for the Hell Gate Arch

Methods Employed at the Ambridge Shops for the Manufacture of the Principal Members of the 977½-Foot Spandrel-Braced Arch Trusses

THE four-track main span of the Hell Gate bridge across the East River at New York City has two spandrel-braced arch trusses 977½ ft. long between centers of skewbacks. With the floor system and bracing they will contain about 19,000 tons of high-carbon structural steel. The floorbeams and the sections of the parabolic lower chords are of unusual dimensions and weight, requiring great care and accuracy in fabrication and involving special methods and plant for the bridge-shop work.

The main bridge shop at Ambridge, Pa., where the members of this span were principally fabricated, is a steel frame structure 776 ft. long and 270 ft. wide, with an end transept 330 ft. wide and 130 ft. long equipped with two 40-ton and two 30-ton overhead cranes and used as a finishing department, in which the planes and boring mills are the only machine tools installed.

ARRANGEMENT AND EQUIPMENT OF SHOP

The general arrangement and equipment of the shop provides for a universal longitudinal movement of all materials on four 30-in. full-length surface tracks which extend into the shipping yards. All transverse movement of materials is effected by forty-two overhead cranes of from 5 to 40 tons capacity which run on the lower chords of all the roof trusses, from one to four of these cranes being located in each panel.

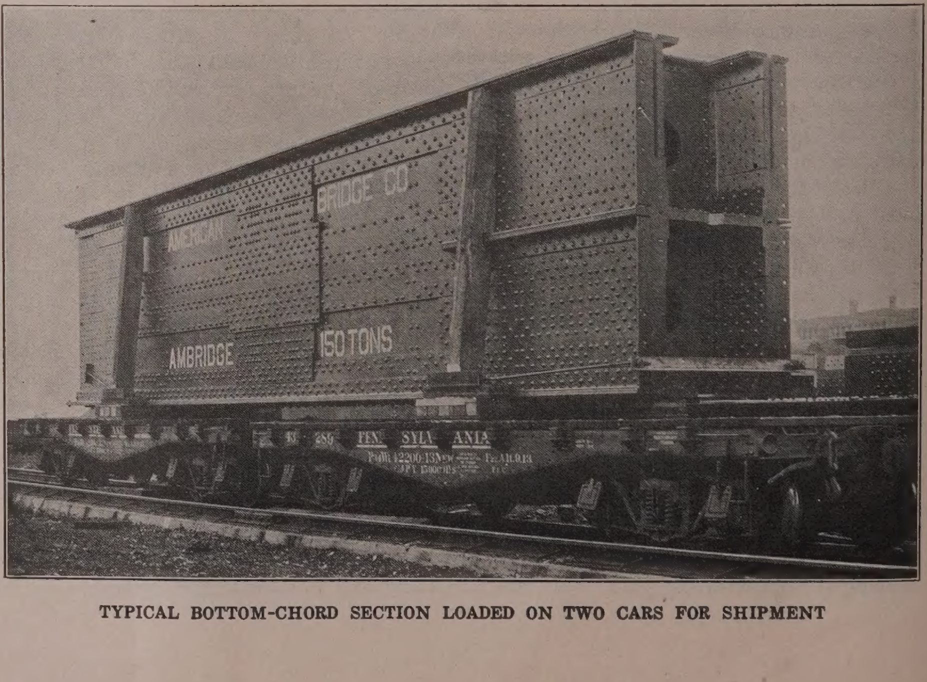
Riveting is done by two 100-ton vertically moving hydraulic machines with a 6-ft. gap and a 6-ft. lift, capable of driving 1¼-in. rivets with 9-in. grips. There are also vertically moving 60-ton pneumatic riveting machines of 5-ft. stroke. Work is passed through both classes of machines while suspended from traveling gantry cranes. The 60-ton pneumatic riveting machines are also served by wall jib cranes which handle the cover-plate work. The laying out, punching, fitting, reaming and riveting operations are carried on simultaneously and consecutively without involving any backward movement of material. Reaming and drilling is all done by gantry machines operating multiple adjustable drills.

LOWER-CHORD SECTIONS

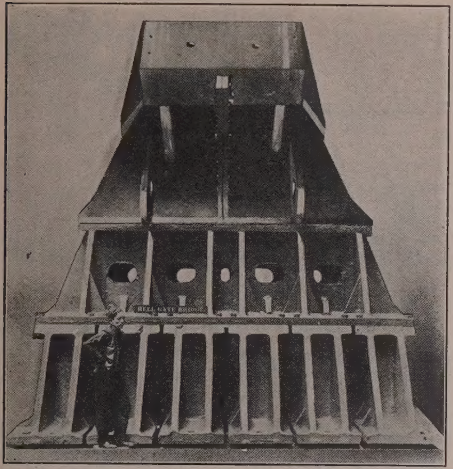
The lower chords, which were described in the Engineering Record of Sept. 12, page 209, have an H-shaped rectangular cross section 6¾ ft. wide over all, with a maximum depth of 11¼ ft. The shipping length of the heaviest member is about 51 ft., and the maximum cross-sectional area is 1385 sq. in. The total weight is about 175 tons, although the shipping weight is reduced to about 150 tons by the omission of splice plates and other connections. The joints are, for the middle third, in contact on radial lines of the parabolic curve of the chords. The outer thirds of the joint are slightly tapered to give a clearance opening at the top and bottom flanges of the member.

The section consists of two built I-beams with heavily reinforced webs spliced on the center longitudinal line and connected by a continuous horizontal center longitudinal diaphragm. The field connections at the end of the sections are riveted through multiple splice plates. The dimensions of these chords and of the elements from which they are built, as in the case of the pedestals and some of the other principal bridge members, were determined by the maximum sizes of material available and by the transportation facilities.

All of the rivet holes in the flange angles



TYPICAL BOTTOM-CHORD SECTION LOADED ON TWO CARS FOR SHIPMENT



CAST-STEEL PEDESTAL AND SKEWBACK SHOE

and web plates are drilled from the solid by the gantry machines. All sheared plate edges are finished by two cuts in the 40-ft. planing machines. The built I-beams forming the cross section are supported at one end by a traveling gantry and at the other end on a track, and are riveted in the 100-ton hydraulic machines before being assembled together in the completed chord section. These pieces have a maximum weight of about 60 tons each, and after being riveted up are assembled together in pairs with the horizontal diaphragm supported on double 24-in. I-beam skids. As much of the pneumatic hammer riveting as possible is done before the cover plates are attached to the built I-beams, after which the assembled piece is riveted up in the same manner as the separate parts.

FINISHING ENDS OF CHORD SECTIONS

The beveled ends of the lower-chord sections are accurately faced to required length and angle by a special electrically driven turntable planing machine with a fixed bed 70 ft. long and a massive concrete foundation. This machine is installed in a 40 x 50-ft. steel building about 30 ft. high, which was erected for it and is provided with a horizontally moving roof and full height end doors to allow the sections to be delivered to the machine and removed from it by the yard gantry crane. The base of the planer, which is about 18 ft. in diameter, has a circular circumference with 4-min. graduations, which allows it to be set at any required angle with the axis of the fixed bed on which the piece is bolted.

All of the chord sections are first set on the planer bed with their webs in horizontal position and a vertical cut of from ½ to ⅞ in. is made on the vertical diaphragm by two cutting tools arranged so that one cuts at the forward stroke and the other on the return, thus avoiding all loss of time. The heads are then turned 90 deg. and a corresponding horizontal cut is taken on the main web, after which a vertical finishing cut of from 1/32 to 1/16 in. is taken across the entire end of the piece, both tools operating together as before to provide continuous cutting. The two cuts required for each end of the chord section are made in about twelve hours. In the two trusses there are altogether a total of 184 chord ends to be finished.

GENERAL OPERATIONS

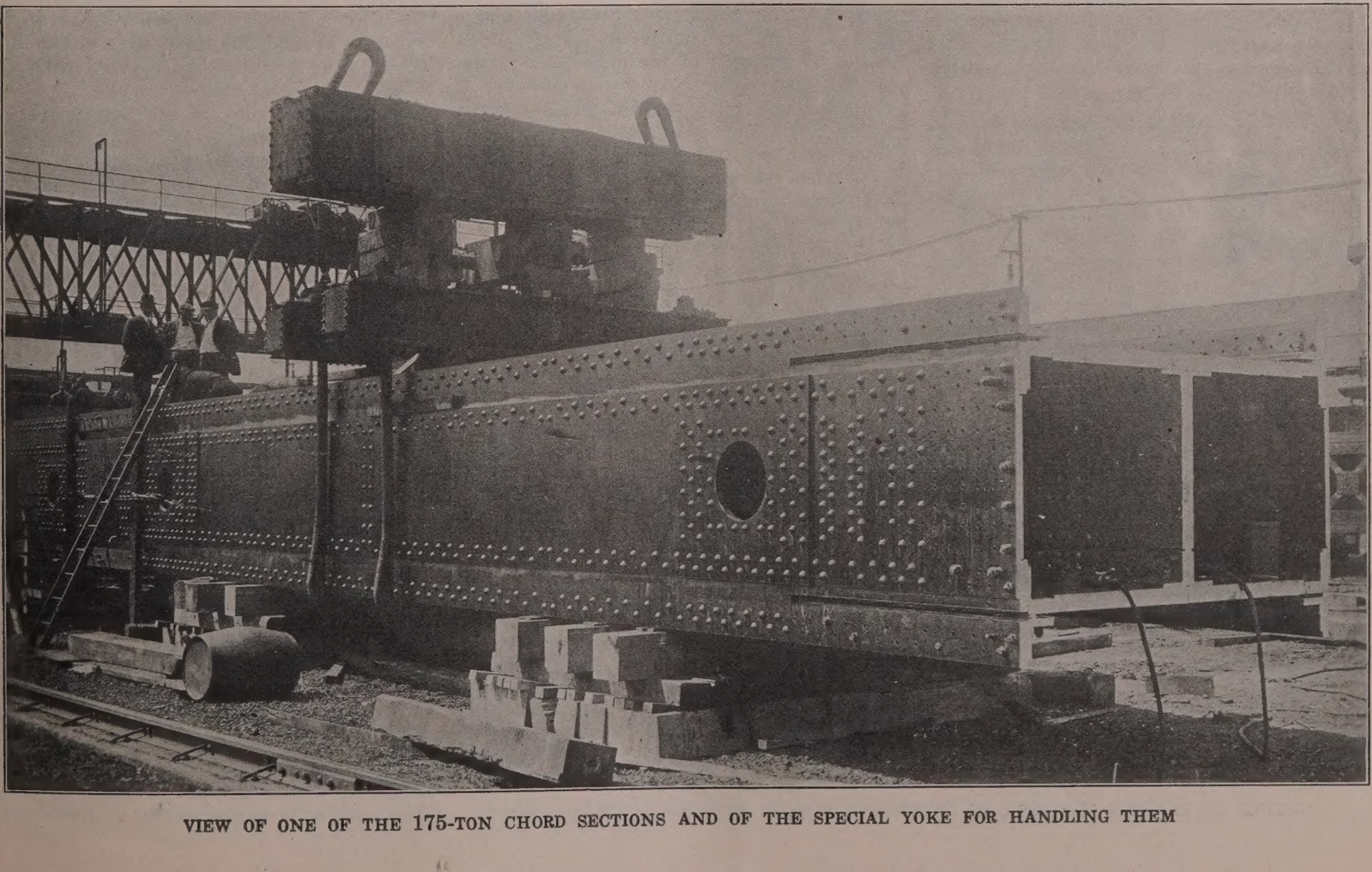
Both ends of all floorbeams and stringers are simultaneously faced by a double-ended 60-in. rotary planing machine and in all members having pin holes at both ends the holes are simultaneously bored by a double-ended boring machine, thus insuring absolute uniformity of length for all pieces finished at the same setting of the machines.

A large proportion of the rivets used in the principal truss members have a diameter of 1¼ in. and are tapered 3/32 in. It is stated that no difficulty whatever has been encountered in drilling, assembling or riveting the pieces. In order to determine the greatest efficiency that might be attained for drilling, experimental plates were assembled together to a combined thickness of 7 in., and through them one hundred 1 5/16-in. holes were drilled at different rates of speed and feed. The holes were filled with rivets, some driven by hydraulic machines and the others by Boyer pneumatic hammers. Sections were then cut through the plates and both pneumatic and hydraulic driven rivets were found to fill the holes completely and to be satisfactory.

ASSEMBLING TRUSSES AT BRIDGE SHOP

In order to insure the accuracy of the work both of the main arch trusses are completely assembled on skids in the bridge-shop yard. Owing to their great size it was impossible to provide space for the simultaneous assembling of all members of the truss, and the trusses were therefore assembled in four-panel sections, the last panel of each section remaining in position to be assembled to the first panel of the next section, thus insuring perfect continuity of construction.

The very large and heavy truss members are handled for fabricating purposes, storage and assemblage in the yard by a special electric gantry crane of 130-ft. span and 28-ft. vertical clearance operating on a track with reinforced-concrete stringers supported on concrete piles driven through the cinder fill. The gantry was designed and built by the American Bridge Company and is equipped with two 75-ton trolley hoists and two 10-ton auxiliary hoists. The trusses are assembled on special skids which distribute the very heavy concentrated loads through foundation grillages laid on the surface of the ground. The trusses are assembled in accordance with special diagrams giving the lengths, angles and offsets required. They are very care-



VIEW OF ONE OF THE 175-TON CHORD SECTIONS AND OF THE SPECIAL YOKE FOR HANDLING THEM fully leveled and the alignment and elevations are checked daily by transits and levels and corrected if necessary by accurate shimming and other adjustments. The accuracy of the design and work is such that so far the panel points have varied less than 1/32 in. from exact elevation and the field joints match without visible imperfections. This test is the more exacting in that when thus assembled the ends of the lower chords take bearing across their full width and are afterward returned to the planing machine to have their outer thirds beveled.

REAMING

All field joints of the trusses are reamed in the yard by four portable electric reamers handled by the gantry cranes. They have 8-ft. radial arms that can be set in either horizontal or vertical position and are provided with long shank drills which will engage both webs of the member. Twist drills are being used without lubrication. The heaviest finished pieces will be shipped from the site on special cars of 150,000 lb. capacity, built for this purpose.

On Oct. 1 about 11,500 tons of the span had been fabricated, including about 75 per cent of the floor system, the fabrication of which was begun in July, 1913. The first four panels at each end of each truss had also been assembled in the yards and it was expected that more panels at each end of each truss would be completed by Jan. 1, 1915.

The bridge is being built for the New York Connecting Railroad, of which Samuel Rea is president and Gustav Lindenthal consulting and chief engineer. The American Bridge Company is the contractor for the fabrication and erection of the steelwork.

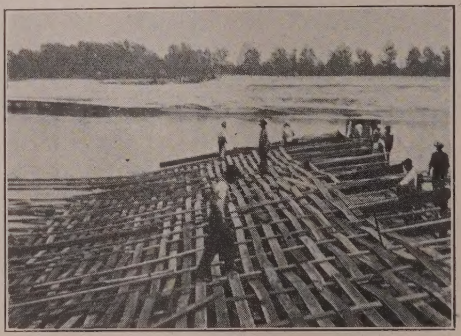
LOWER TOLLS through the Cape Cod Canal have just been made effective by the Boston, Cape Cod & New York Canal Company. The new rates are designed to meet the needs of crude material carriers, and vessels carrying such loads through the canal may use the canal free when returning empty.

Lumber Mattresses for Bank Protection in Louisiana

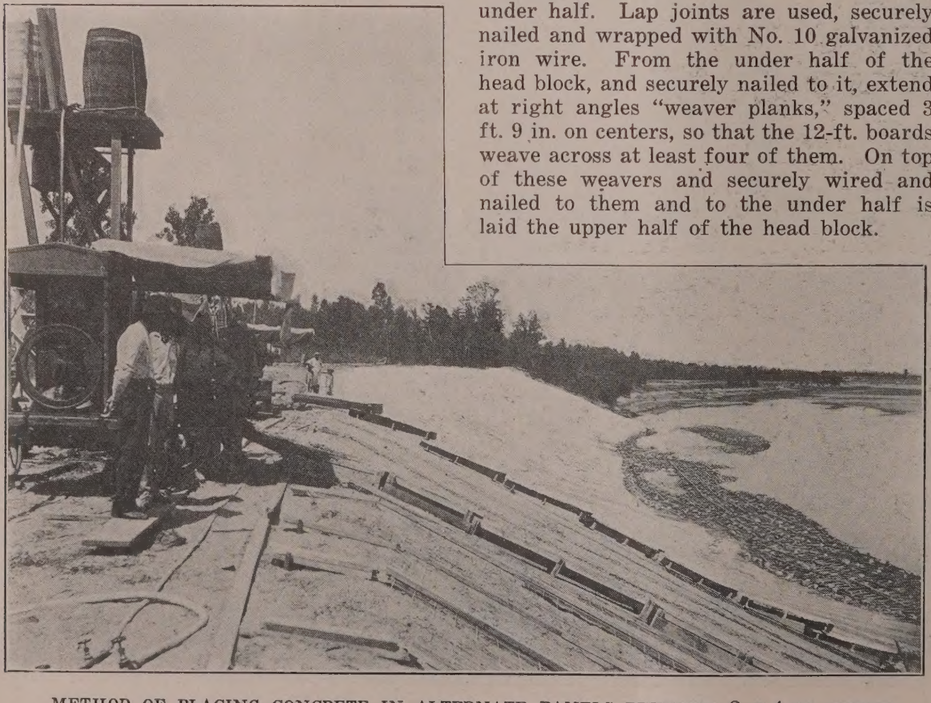
Caving Levees Are Surfaced by Reinforced Concrete Above Low Water Level and by Stone-Loaded Mats of Woven Boards Below

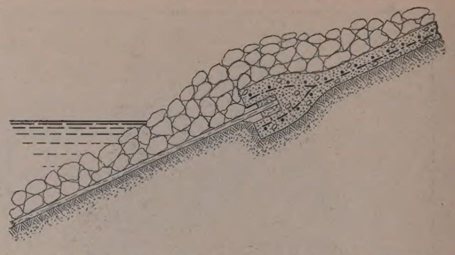
LUMBER mattresses for bank protection, built parallel with the shore on pontoons and sunk in place, are being used by the contractors on the Caddo levee district in the northwestern part of Louisiana. The district is bounded on the east by the Red River and has a river frontage of approximately 125 miles. The total area protected is about 145,000 acres.

After the river bank has been shaped by a floating drag-line outfit and given a slope of 1: 2, the subaqueous mattresses are placed. These mattresses are of the "lumber" type, similar to those used by the Mississippi River Commission. They vary from 75 to 125 ft. in width, averaging about 100 ft., and extend at least 25 ft. beyond the toe of the slope of the bank.


WEAVING AND LAUNCHING MATTRESS

Lumber mattresses are specified because of the scarcity of willow brush. The lumber is of any variety that will not break, split or warp before the mattress is sunk and whose strength and usefulness is not impaired by large knots, shakes or other defects. The dimensions are from 1 x 4 to 1 x 6 in. in lengths of about 12 ft. About 30 per cent of the material is about 16 ft. long. The head block consists of one thickness of 1 x 6-in. plank for the under half. Lap joints are used, securely nailed and wrapped with No. 10 galvanized iron wire. From the under half of the head block, and securely nailed to it, extend at right angles "weaver planks," spaced 3 ft. 9 in. on centers, so that the 12-ft. boards weave across at least four of them. On top of these weavers and securely wired and nailed to them and to the under half is laid the upper half of the head block.


METHOD OF PLACING CONCRETE IN ALTERNATE PANELS BETWEEN 2 X 4-IN. STRIPS


JOINT BETWEEN LUMBER AND CONCRETE

The planking runs over and under the weavers. Each course breaks joints with the next and as far as possible, by the use of planks of different lengths, the plank ends are left on top of the weavers. Planks and weavers are securely nailed together. The courses of planking are laid with open spaces of 4 to 5 in., so that the stone covering does not pass through the mattresses.

Galvanized steel wire cables ⅝ in. in diameter are made fast to the head block and to four of the weaver ends nearest the outer edge of the mattress, one at each weaver, the spacing growing wider towards the middle of the mat. These cables are wound around the weavers and securely fastened with staples while under strain from a capstan. At 25-ft. intervals cross binders, consisting of two to three thicknesses of planks, breaking joints and well nailed together, are spiked to the top stringers and wired to the mattresses.

For building these mattresses the contractor constructed a pontoon on top of which is the working platform. This pontoon is hauled parallel to the shore a distance corresponding to the finished part of the mattress. As soon as the mattress has left the pontoon it is sunk by loading it with stones weighing from 20 to 100 lb.

UPPER BANK PROTECTION

Where the upper bank concrete pavement and the subaqueous mattress join care is taken to secure the joint against wash and injury. This has been accomplished by forming a fork in the lower edge of the concrete around the upper edge of the mattress. The joint is then covered with riprap.

The upper bank, or the portion of the levee above ordinary low water stage, has been paved with reinforced concrete. After the slope had been graded, tamped and rolled, 2 x 4-in. strips were placed on the flat side normal to the river, with alternating spaces of 5 ft. and 4 ft. 4 in. dividing the slope into panels. Wire net reinforcement with overlapping edges was stretched over these strips and held in place by other strips, superimposed on the original strips and nailed to them. The concrete was then placed in alternate 5-ft. panels by a movable mixing plant run on the top of the bank. After the concrete had set the strips were removed and a second traveling mixing plant concreted the remaining panels. The reinforcement consisted of galvanized iron wire netting with 6-in. square and No. 10 wire. The concrete mix was 1: 4: 6 and tamped in place.

The total estimated cost of the work is about $350,000 and the length of the protection work is about 5½ miles.

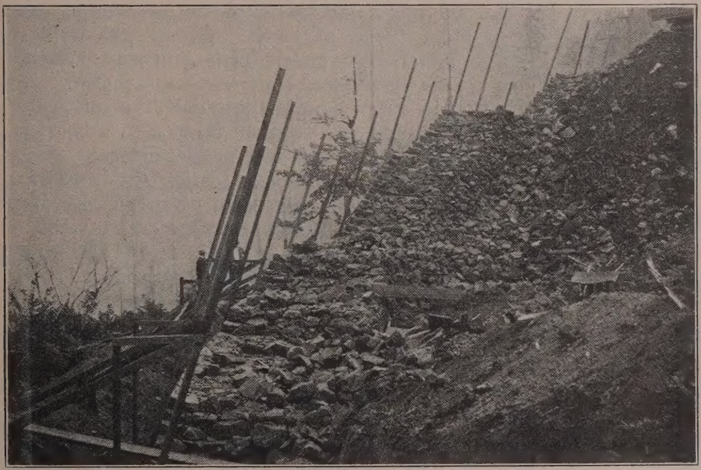
Major Frank M. Kerr, chief of the State board of engineers, assisted by Gervais Lombard, drew the plans and specifications and the work is being executed by the Miller Engineering Company, of Little Rock, of which Charles H. Miller is president and A. C. Butterworth, vice-president.

Dry Masonry Walls for Highway Embankments

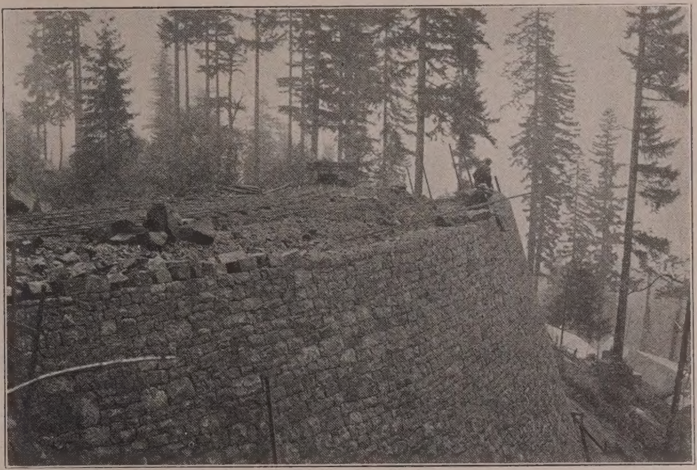
European Wall Construction Methods Successfully Applied on Oregon State Highways

THE idea of constructing dry masonry walls up to 50 ft. in height has been imported from Europe and is being applied successfully on the highways constructed by the Oregon state highway commission in Multnomah, Clatsop and Columbia Counties. A total length of 4 miles of these walls has been built for the commission, and up to date all are giving satisfactory service. Considerable more construction of the same type is contemplated because of its cheapness and solidity. Settlement cracks do not appear in this type of wall.

The illustrations herewith show a dry masonry wall on the Portland-Astoria highway, with a maximum height of 51 ft. and a length on curve of 380 ft. The radius of the curve is 100 ft., thus making the central angle greater than a half circle. The toe of this wall was commenced in a trench 10 ft. below ground level and the base is stepped up and back into the hill. At the surface of the ground, 41 ft. below the crest, it is 23 ft. thick.



CROSS-SECTION OF WALL SHOWING SLOPE GUIDES



FACE OF COMPLETED DRY MASONRY WALL

SIMPLE DESIGN

In all of the walls which the commission has built it has been found preferable to make the base about six tenths of the height, although this ratio may vary from four to eight tenths, according to the backfill and the foundation. The base is not horizontal, but is, rather, laid at right angle to the face. The face slope is usually three tenths to one, and where an earth backfill is to be used an equal slope is made on the back of the wall. For a rock fill, however, the back of the wall is made perpendicular. The backfill is usually placed as the masonry work progresses, and thus the workmen do not require staging.

An instrument is used to check up the position of the walls every few days so that any movement might be detected, but only very slight settlements have occurred thus far. In one case a settlement of about 1 in. occurred when the wall was only 16 ft. high, and afterward the wall was continued to a height of 50 ft. without any further movement appearing.

The only fault that has called for repair thus far has been the appearance of small local bulges on the face of the wall. These have always been found to be caused by the failure of poor stones in the interior, and the location of these faults has shown that natural disintegration of the rock, rather than an excess of pressure, caused the failure. Trenches are provided to drain off surface water above the walls so as to protect them as much as possible from seepage.

MATERIALS, LABOR AND COST

It has been found feasible thus far to supply material for these walls free of charge, because they have been within the free haul of spoil from basalt rock cuts. No special attention is paid to getting this rock out; it is simply blasted in the ordinary way, and the little squaring up that is necessary is done by stone masons. Except near the ends of the wall only stones such as one man can easily handle are placed in the face.

The walls are built according to two distinct patterns; the Greek wall, constructed in regular single courses, such as that shown in the illustrations, and the Italian type, which is built without any attempt to place the stones in regular courses, but in which every small opening is chinked with spalls.

It has not been found feasible to build these walls with American labor, but there has been no difficulty in securing men from the Greek or Italian road crews who have had experience in this work in Europe. These men are paid $2.75 per 8-hr. day, and the foreman gets $3.25. The cost of the walls, exclusive of backfill, has been found to average about 60 cents per cubic yard or $2.25 per square yard of face.

Henry L. Bowlby is State Highway Engineer of Oregon, and the construction on the Portland-Astoria sections of the Columbia highway is being carried out under the supervision of L. Griswold, assistant highway engineer. The Multnomah County section of the Columbia Highway is under the supervision of S. C. Lancaster, assistant highway engineer.

A NEW SPEED-CONTROL SYSTEM of signaling is to be installed by the General Railway Signal Company on the lines of the New York dual subway system to be operated by the New York Municipal Railway Corporation. Instead of stopping absolutely a train that fails to slow down at the proper signal, the new device will reduce the speed greatly, minimizing the danger from collision without the loss of time due to a full stop.

Efficiency of Highway Organization

Abstract of Paper Read at Fourth American Road Congress, Held in Atlanta, Ga., Nov. 9-14, 1914, by Col. E. A. Stevens, State Highway Commissioner of New Jersey

GIVEN a force that can lay out a competent plan, unhampered by political meddling, the cost for a highway system can be forecast. Taking this as a text, Col. E. A. Stevens, State Highway Commissioner of New Jersey, elaborated on it in a paper read at the Fourth American Road Congress, held in Atlanta, Ga., Nov. 9-14, 1914. Changes in traffic, he continued, may lead to changes in general design and detail, as happened at Panama, without making efficiency impossible. This happens so often with even so simple a task as building a house that the wise man always allows some margin on the first detailed estimate of cost. With the cost known, plans for raising money can be made for meeting it, and a program of construction arranged with a view to giving the earliest and greatest return for the money spent. The following notes have been taken from Colonel Stevens' discussion of the detail of these procedures.

Bond issues and the "pay as you go" plan must be considered. It is evident that over any period for which bonds are issued the tax levy must include interest and amortization charges on the bonds, as well as the cost of caring for the roads built, and must also cover depreciation. If the same amount be raised each year by taxation, and used to meet road building, repair and depreciation charges, it is clear that the amount raised for interest and amortization, and, in the first part of the period, some of the amount raised for repair, etc., can be used for new work. The net result over the whole period is a reduced cost for a given mileage. Against this we have the use of the roads built for a longer average time. This benefit will, in many cases, be cheap at the increased price. but only on the assumption that bonds are issued on some definite and business-like plan, and the proceeds wisely invested. This has not always been the case.

We must first create, however, a capable repair force and a system of accounting that will give accurate data and that is based on an outlook over a period somewhat longer than that covered by next year's tax bill. On the basis of such a system and with such a force are our railroads operated. Their problem is of the same kind as ours—a matter of cheap and efficient transportation. It is perhaps curious that while the tendency of the day is to regulate these and other public service corporations as to the safety and adequacy of their service, and as to their methods of financing, the people of this country have in no case insisted on such safeguards as to the work of those entrusted with their roads.

With our highways problem we are now searching for the best solution. We have, generally speaking, inadequate and untrained or only partly trained forces. We have no accepted traffic unit and no generally recognized system of accounting. These must be supplied if we are to solve our problem as it should be solved.

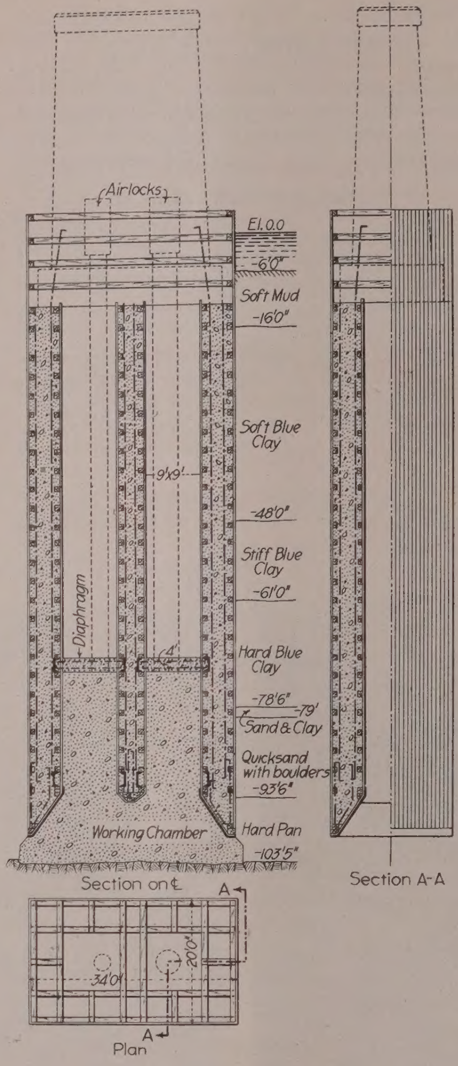
Mud Lake Bridge Substructure

Piers Were Sunk to Maximum Depth of Nearly 104 Ft. by Combination of Open-Dredging and Pneumatic-Caisson Processes

FOUNDATIONS for the Mud Lake Bridge on the new low-grade line of the Canadian Pacific Railway from Toronto east toward Montreal, known as the Campbellford, Lake Ontario & Western Railway, features of which were described in the Engineering Record of June 13, page 675, were sunk to rock through deep strata of soupy muck and clay so soft that it would not sustain a man's weight, nor permit of the usual method of loading and excavating pneumatic caissons. The concrete piers were, therefore, built above the surface, provided with open dredging wells and sunk by excavating through them until it was deemed profitable to close the bottoms of the wells by permanent diaphragms, after which the sinking was continued by hand excavation under pneumatic pressure.

The railway crosses Mud Lake about 150 mi. northeast of Toronto, at a point where the soil consists of successive layers of liquid muck, soft blue clay, stiff blue clay, hard blue clay, quicksand and boulders and hardpan extending from the bottom of the lake to solid rock. The rock slopes downwards from the ends of the bridge to about 100 ft. below water level at pier 2, where the excavation was carried to a maximum depth of 103 ft. 8 in.

CONSTRUCTION OF PIER 2



DETAILS OF CAISSON

The position of the pier was accurately located on the heavy ice and a form for the lower 12 ft. was built in the correct horizontal position. It had a rectangular cross-section, with an outer wall and two inside rectangular dredging shafts made of vertical boards spiked to horizontal frames of 12 x 12-in. timbers about 4 ft. apart on centers vertically. The outer walls were seated on timber and steel cutting edges, from which inclined wooden sheeting extended up to the bottom of the shaft, which was at a higher elevation, thus forming a flaring chamber at the foot of the shaft and allowing the excavation to be extended from the center of the shaft to the cutting edge.

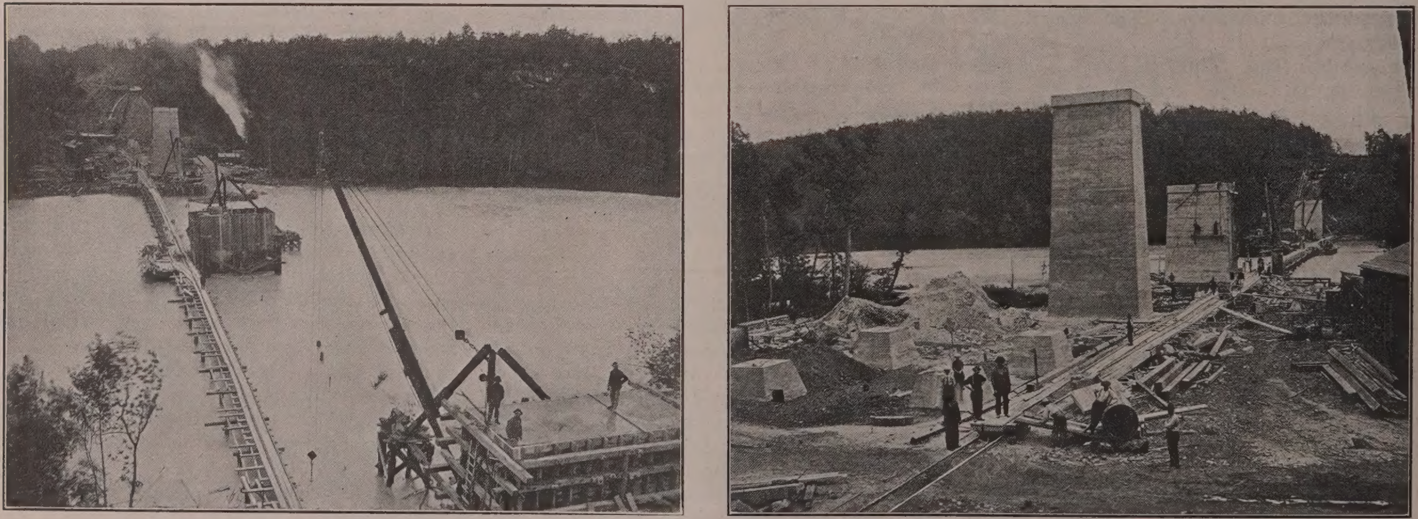
After the walls were concreted the caisson was suspended by four wire-rope tackles from the tops of falsework pile bents driven alongside, the ice was cut away and the caisson lowered to bearing on the soft bottom of the lake. The sides were then extended up to the full height of about 100 ft. as the pockets between the walls were concreted, and the caisson was sunk to a depth of about 50 ft. without dredging.

At this depth the material was dredged out with a 1-yd. clamshell bucket operated by a stiffleg derrick alongside, the shafts were pumped out and men entered and closed them by horizontal reinforced-concrete diaphragms 4 ft. thick built into recesses prepared to receive them. Air shafts and air locks were installed, pneumatic pressure was applied and the sinking completed by hand excavation, the spoil being removed in buckets. A maximum pressure of 47 lb. was developed, and under it the work was executed in 40-min. shifts.

Pier 3 was of the same lateral dimensions as pier 2 and was sunk in the same manner to a depth of 59 ft. Pier 4 was built in detachable wooden forms and was of standard reinforced-concrete construction. It was started on the ground at about water level and was sunk 40 ft. to a rock bearing. The excavation was made entirely under pneumatic pressure, and the working chamber was concreted twenty-eight days after the design of the pier was started.

The work was executed under the direction of the engineering department of the Canadian Pacific Railway, of which C. W. P. Ramsey is engineer of construction and P. B. Motley, engineer of bridges. The contractor was the Foundation Company, Ltd., with A. I. Campbell, superintendent.

BURNING EMPTY DYNAMITE CASES is discussed in the DuPont Magazine. It is essential in destroying dynamite to take it out of its wooden case, as the nails are apt to cause an explosion when the flame reaches them. Any cases showing signs of being stained with nitroglycerine should not be used for fuel but burned in the open. A little excelsior or waste should be soaked in gasoline and placed under the empty cases. One end of a piece of fuse 2 or 3 ft. long should then be lighted and the other end placed in the excelsior, or the workman may lay a train of excelsior, light one end with a match, and run.



TWO CONSTRUCTION VIEWS OF MUD LAKE BRIDGE, CAMPBELLFORD, LAKE ONTARIO & WESTERN RAILWAY

Pneumatic Track Tamping

Compressed Air Replaces Hand Methods in Portable Outfits in Use on New York Central & Hudson River Railroad

COMPRESSED air is being used successfully for tamping ties on a part of the New York Central & Hudson River Railroad. The tamping outfit consists of two pneumatic tampers, 600 ft. of ¾-in. hose and an air compressor mounted on a hand car. The compressor is driven by a gasoline engine, which also propels the car itself at a speed of from 12 to 15 mi. per hour. The car will carry twelve men and is equipped, as one of the illustrations shows, with cross trucks, with the aid of which four men can remove the car from the track in less than a minute.

One of the illustrations shows the two tampers in use, with one man for each. Each tamper is fitted with a tamping bar of the ordinary shape, and weighs, complete, 37½ lbs. It is stated that the machine is equally effective for stone, gravel or cinder ballast, that it can be worked to advantage around frogs and switches where hand tamping is difficult or impossible, and that trackmen prefer it to the tamping pick or the tamping bar. A performance record kept on one of the units through the entire season of 1913 showed a tamping cost of 2.6 cents per tie with the machine, as compared with from 10 to 20 cents by the hand method. The record also showed that two men can average 300 ties per day.

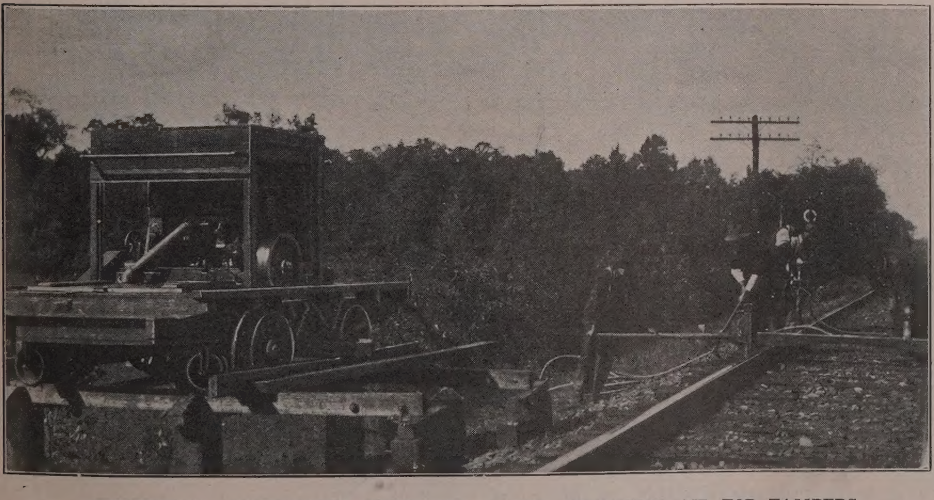
TAMPING A TIE WITH TWO MACHINES

A service test was made some time ago to determine the comparative stability of track tamped by hand and that tamped pneumatically. A section of track on the West Shore Railroad in the Hackensack Meadows in New Jersey was selected, where the foundation is soft and it is difficult to maintain the track in good condition. An 800-ft. stretch of track was tamped by machine and an equal length by hand. After six months observations showed settlement as given in the accompanying table.

TRACK SETTLEMENT IN INCHES AFTER HAND AND MACHINE TAMPING

	Greatest	Least	Average
Hand tamping..........	0.116	0.018	0.067
Machine tamping.......	0.063	0.004	0.033

The compressor cars and pneumatic tampers are manufactured and sold by the Ingersoll-Rand Company, of New York City. The New York Central & Hudson River Railroad now has twelve outfits in service.



COMPRESSOR CAR REMOVED FROM TRACK AND SUPPLYING AIR FOR TAMPERS

Some Recent Tests of High-Power High-Speed Water Turbines

Supplementary Article Dealing with Holyoke Test 2359, Giving 93 Per Cent Maximum Efficiency, and 2363, Giving 90.7 Per Cent

By S. J. ZOWSKI

Professor of Mechanical Engineering, University of Michigan, Ann Arbor, Mich.

WHEN the article bearing the above title and appearing in the Engineering Record of Nov. 28, page 585, went to press the author was studying and analyzing some new reports of noteworthy Holyoke tests, which must now be recorded as marking further important progress in the art of designing and building high-power high-speed water turbines.

During the months of September and October a number of tests were made at the Holyoke testing flume by James Leffel & Company, of Springfield, Ohio. Some of these tests were carried out for purposes of study and were continuations of former similar systematic experiments. Other tests were made to see what some newly developed turbine types would yield. Of this latter group of tests the results obtained with an improved Samson wheel, designed and built by James Leffel & Company, and also the results obtained with the latest wheel type designed by the author for and built by the same company will be put on record.

TEST 2359

Fig. 11 (continuing the notation in the original article) shows the equal-efficiency curves of the first wheel (Holyoke test 2359). This wheel is a further improvement of the Samson wheel test 1900, the curves of which were given in Fig. 2 of the previous article of Nov. 28. (An error gave this wheel the number 1889 instead of 1900.) We see that the unprecedented efficiency of 93 per cent was realized, with a unit speed of 47.2 r. p. m. and unit power 2.7, as against 90 per cent efficiency with a speed of 45.3 and power of 2.48 obtained with the wheel test 1900. The general good characteristics of operation of the Samson wheel which were pointed out in the original article did not suffer, as is apparent from the broadness of the curves of this new wheel. This wheel now holds the record of the highest efficiency ever obtained in the Holyoke testing flume, and when we consider the speed and power value of the turbine type characteristic $K_t=77.6$—we must indeed admit that the result is astonishing. The development of the Samson wheels is due to A. F. Sparks, general manager of James Leffel & Company. It was made possible only by going at it in a systematic way, by making exhaustive research in the Holyoke flume, which work extended over a period of about twenty years.

TEST 2363

Fig. 12 shows the equal-efficiency curves of a wheel designed by the author for James Leffel & Company. This is test 2363, the author's latest design. The best efficiency reached a value of 90.7 per cent with a type characteristic $K_t=102$, which means a power increase of 25.5 per cent over that of the author's wheel Zowski V, with an efficiency increase of 0.6 points (see Fig. 7 of the first article). The general characteristics of the wheel did not suffer at all, as is apparent from the shape of the curves when they are compared with the curves shown in Fig. 7 of the original article.

It is interesting to note that both wheels had draft tubes of the same length and the same discharge diameter, making the final discharge loss of turbine 2363 1.1 per cent greater than that of turbine 2359. This means that the rest of the hydraulic losses of turbine 2363 is $93-(90.7+1.1) = 1.2$ per cent higher than for turbine 2359. Considering that turbine 2363 has actually 54 per cent and relatively (that is, when reduced to same speed) 67.1 per cent more power than wheel 2359, the increase of hydraulic loss does not seem to be excessive. From this we might draw the conclusion that if the efficiency of 93 per cent is the highest value we can reach with a wheel having a type characteristic of about 78—and this estimate can not be far from right—then the efficiency of 90.7 per cent must be very near the maximum for a wheel having a type characteristic of about 102. To Figs. 8, 9 and 10, originally drawn to show the power-efficiency curves discussed in the previous article, have been added in heavier lines the corresponding curves for the wheels 2359 and 2363.

It must be added and emphasis must be laid on the fact that neither of the turbines should be considered in the light of experimental apparatus, nor should either of the tests be regarded as show tests. The turbines were of commercial design and construction in every respect. The runners were substantially and strongly built, and no modification in the bucket design will be necessary for whatever actual service the turbines will be used in, or whether they will be of single, twin, triplex or quadruplex type. Similarly the guide case was built in a substantial and commercial manner. The guide yanes were of the regular flutter type, operated by a shifting ring. Their shape and thickness were regular. The workmanship was first class, to be sure, but without exaggeration, such as polished surfaces.

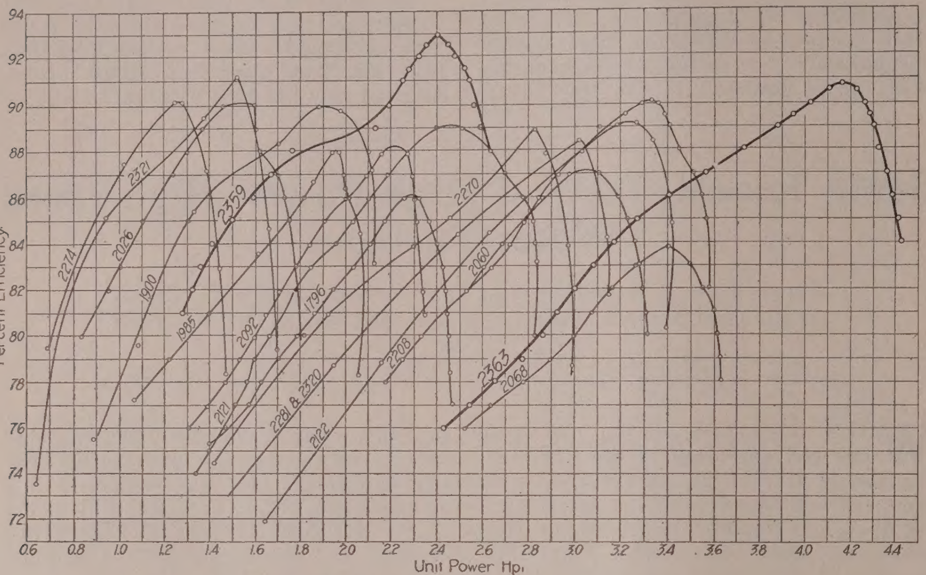


FIG. 8—POWER EFFICIENCY CURVES FOR WHEELS HAVING A NORMAL SPEED OF 50 R.P.M. UNDER A HEAD OF 1 FT.—NORMAL SPEED CURVES

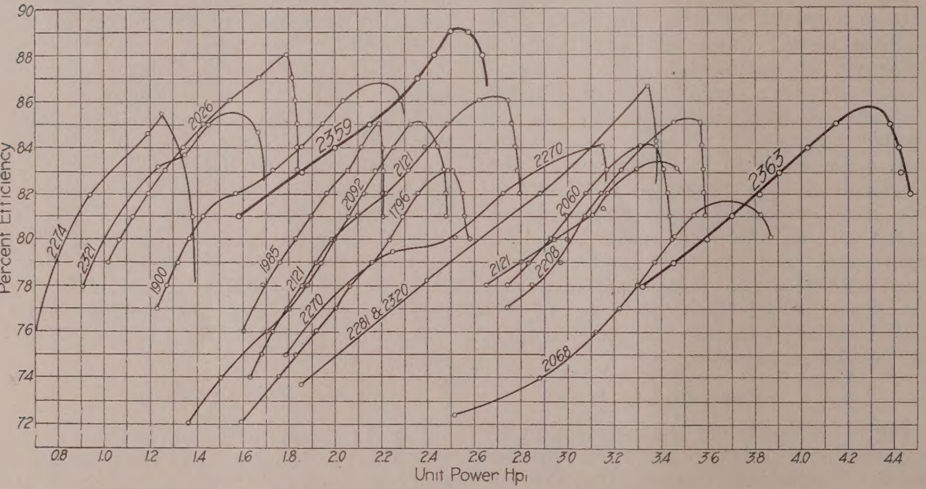


FIG. 9—POWER EFFICIENCY CURVES FOR WHEELS HAVING A NORMAL SPEED OF 50 R.P.M. UNDER A HEAD OF 1 FT.—CURVES FOR 15-PER CENT OVERSPEED

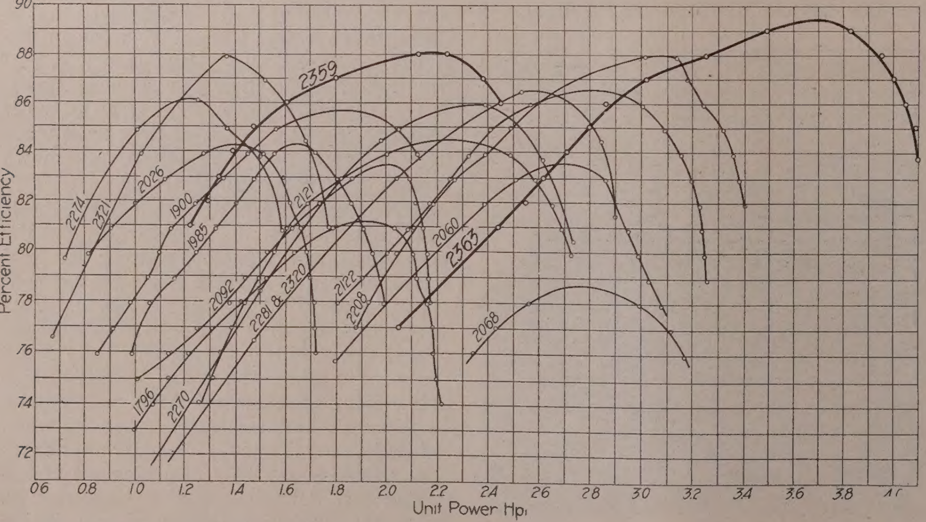


FIG. 10—POWER EFFICIENCY CURVES FOR WHEELS HAVING A NORMAL SPEED OF 50 R.P.M. UNDER A HEAD OF 1 FT.—CURVES FOR 15-PER CENT UNDERSPEED

THE PENNSYLVANIA RAILROAD had 91,159 stockholders on Dec. 1—the largest number in its history. This is an increase of 3863 during the last twelve months. Of the total number of shareholders 43,913, or about 48 per cent, are women.

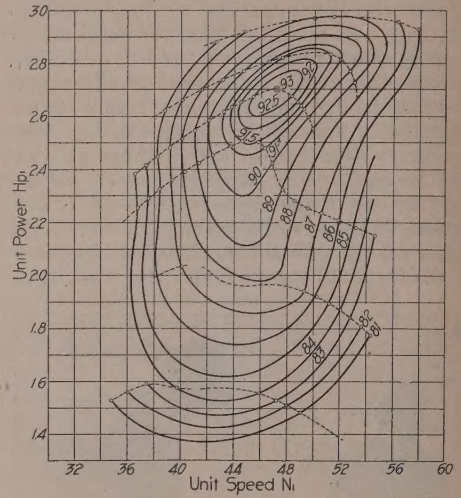


FIG. 11—HOLYOKE TEST RUNNER 2359

Diameter	35 in.
Best efficiency	93 per cent
Normal speed	47.2 r.p.m.
Normal power	2.7 hp
Normal K_t	77.6 (specific speed)
Designer	A. F. Sparks

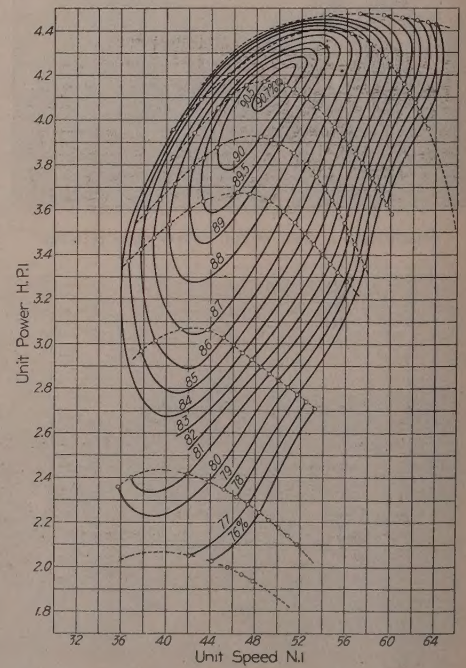


FIG. 12—HOLYOKE TEST RUNNER 2363

Diameter	30 in.
Best efficiency	90.7 per cent
Normal speed	50 r.p.m.
Normal power	4.17 hp
Normal K_t	102 (specific speed)
Designer	S. J. Zowski

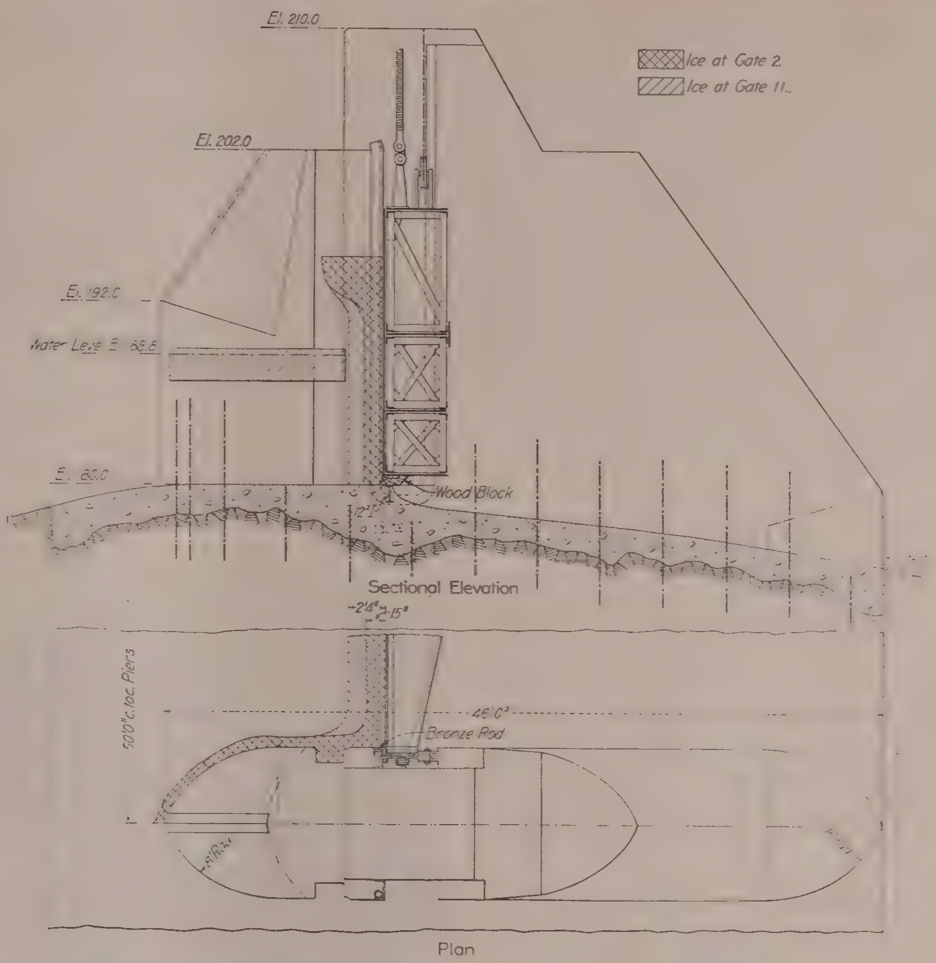
Winter Operation of Stoney Gates

Experiences Early This Year at a Canadian Dam When It Was Found Necessary to Operate a Gate Surrounded by Ice

THE Shawinigan Water & Power Company has built two dams across the St. Maurice River to divert its water for hydroelectric purposes. As the climate is severe and the temperature very often falls below —40 deg. Fahr. during the winter, precautions had to be taken in designing these dams so that the gates could be operated without causing any damage to them. From Jan. 15 to March 1 of this year the temperature was below zero and observations were, therefore, made to determine the length of time needed to put the gates in operation and in what way the ice formed around them.

CONSTRUCTION OF DAMS

The two dams consist of piers carrying an overhead bridge together with a low concrete sill on top of which are placed Stoney gates. One of the dams has eight 40 x 18-ft. gates, the other twelve 40 x 18-ft. and two 15 x 18-ft. gates. These two smaller gates are housed and heated by hot air from electric heaters, kept in continuous circulation by blowers. These are usually sufficient to take care of any fluctuations in the winter discharge of the river. In order to establish a closed house, concrete curtains were built projecting into the water on both the upstream and downstream sides of the dam. This, however, necessitated the placing of a low cofferdam between the piers on the downstream side so as to back the water up to the downstream curtain, as the sill of the dam practically is out of water at low discharges.



FORMATION OF ICE AROUND PIERS AND GATES WHEN MEASURED ON FEB. 14, 1914

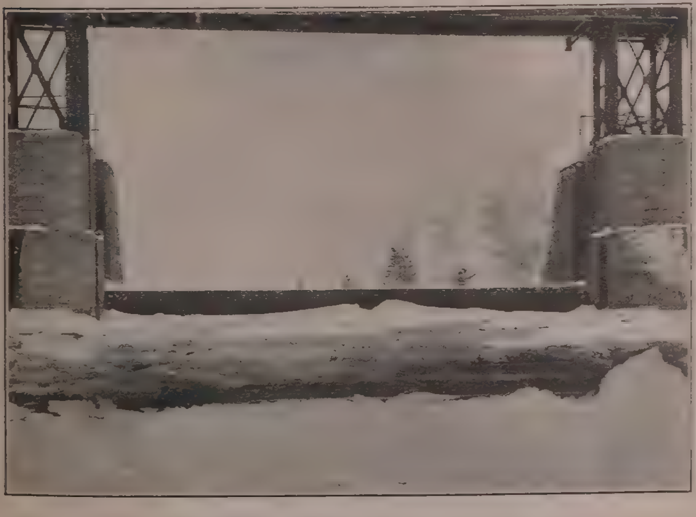
APPLICATION OF STEAM

To facilitate the operation of the larger gates, the dam, which, fortunately, could be located practically east and west, with its back exposed to the south, thus giving the gates the benefit of the heat from the sun, is designed so that the gate slots can be heated by steam. The accompanying drawing shows the location of these steam conduits and one of the photographs shows the piping. In addition to these precautions two of the 40-ft. gates are sheeted on the back so that live steam can be turned into them. This enables the operating force to loosen the bond between the gate and possible ice formation in front of it. The steam plant is kept under fire all winter, that is, the fire is banked underneath a 75-hp boiler, so that steam is available in a few minutes. On April 21 it was found necessary to open one of the gates and eight hours were required before it could be operated. One of the accompanying photographs shows the gate in the open position. The ice below it held against the rush of water several hours before it gave way.

MEASUREMENT OF ICE FORMATION

On Feb. 14 the ice formation around the gates was measured on gates 2 and 11, and the results are shown in the drawing herewith. Gate 2 is covered in the rear by a wooden sheeting, but gate 11 is open. Consequently the ice formed below water on the face of the latter gate was thicker than on the former. The greater thickness of the ice at the top is explained by the facts that the water level was at that elevation when the ice formed, and that repeated fluctuations of the water surface broke the ice. The drawing shows the elevation of the ice sheet on the day of operation.

The chief engineer of the Shawinigan Water & Power Company is Julian C. Smith, and the assistant engineer is Friedrich T. Kaelin. The superintendent of operation is John Morse.



ICE FORMATION IN FRONT OF STONEY GATE

GATE OF DAM PARTLY RAISED, SHOWING ICE BARRIER

Chief Features in Building a Long Concrete Viaduct at St. Louis

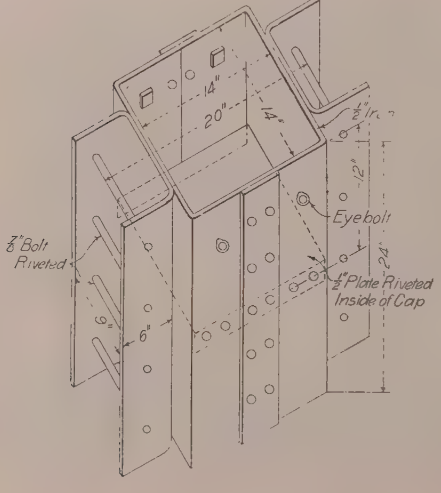
Experiences in Driving Concrete Piles with Two Types of Hammers, and Costs of Some Items in Structure Spanning Thirty-Five "Live" Tracks

By P. A. RICHARDSON
Superintendent, Fruin-Colnon Contracting Company, St. Louis

THE Twelfth Street viaduct at St. Louis, a reinforced-concrete structure 2224 ft. long, including approaches, was opened for traffic Dec. 1. Some of the construction features of special interest to engineers and contractors are here given. The work consisted in removing the foundations, approaches and superstructure of the old bridge, the reconstruction of a 2 x 3 and a 6 x 7 ft. sewer on Twelfth Street, the relaying of 1200 ft. of 36-in. water main, the excavation of thirty-two piers 50 ft. deep to solid rock, the excavation of seventy-eight other piers to depths of from 12 to 18 ft. preparatory to driving piles, the driving of 2000 concrete piles in lengths of from 25 to 35 ft. and the placing of 2,292,400 lb. of reinforcement and 18,000 cu. yd. of concrete. Of this work chief interest centers in the wrecking and construction methods forced upon the contractor by the "live" railroad tracks spanned by the structure, the cost and details of the concrete piles, difficulties experienced in driving them and the concrete plants employed.

Difficulties in Wrecking

The old Twelfth Street bridge spanned thirty-five tracks belonging to the Terminal Railroad Association and the Missouri Pacific Railroad, including the "high line" from the Merchants Bridge and the two tunnel tracks that led upon the Eads Bridge. All the passenger service from the East is carried over these tracks, used by about twenty-seven roads, and all the inbound and outbound freight over these two bridges is handled in the yard under the Twelfth Street bridge. The tracks are live ones and in use almost continuously. It was necessary to take down the bridge, excavate the holes, drive the piles and do all work without handicapping the service of the railroads, and at the same time execute it economically. The attitude of the railroad companies was a most important matter. "Don't interfere with our service and we will help you make time," might fittingly express their position. Many tracks had to be moved and brought into one lead and others temporarily discontinued or cut out entirely. All the work was done in quick time, as the contractor wanted it, and helped immensely with its execution. Needless to say the contractor did everything in his power to facilitate the work of the railroads and discommoded them as little as possible.


CAP USED IN DRIVING PILES

The start was made at both ends of the new work with the excavation for the retaining walls. This work was done with teams and slips and by hand and cost about 60 cents per cubic yard, labor only. The excavation of the thirty-two piers to solid rock was done with a cableway and a Potter machine. The holes were 4 x 8 ft. in size and 50 ft. deep. Only one man could be worked in a hole at a time, and as the holes had to be braced solidly from the top downward the excavation cost was high, $3.50 per cubic yard. If there is any other, cheaper method of excavating and bracing a 4 x 8 x 50-ft. hole than the one used the writer would be pleased to hear of it.

In the meantime the street-railway company and the telephone companies were removing their wires from the bridge—a very slow process. A Browning locomotive crane was placed on the bridge, using the tracks of the United Railways, and put to work tearing down the bridge at the north end. This crane had a 50-ft. boom and weighed 50 tons. The crane would wreck a section of bridge, loading the iron on wagons, then dig the pierholes for the new bridge, uncover the 36-in. water pipe and remove same. A pile driver drove the piles in the holes as fast as the crane could excavate them. By this method the crane was pushed all the time to keep out of the way of the pile driver, and the water-pipe gangs were pushed to keep up so that the crane could handle the pipe. There was not room on or alongside the tracks for the pipe, which was taken up before the relaying ditch was ready in some instances, and it was therefore placed on the bridge in back of the crane. Quite a number of piles were made and stored on the bridge and the crane kept the driver supplied when a carload of piles failed to arrive from the casting yard. The driver was never stopped for lack of piles. When over the tracks the crane loaded the dirt, iron and decking on railroad cars, which generally stood under the bridge in back of the crane. In order to complete the sewer work on the south side and permit of the proper order in the execution of the work, the south approach and four spans of the old bridge were wrecked. This left the crane on the bridge without any approach. When ready a temporary trestle was built at the end of the bridge and the crane run off safely, to the relief of quite a few of the natives. One of the illustrations shows how the final section had to be braced while the crane was still on it.

ERECTION VIEW OF TWELFTH STREET VIADUCT AT ST. LOUIS

Concrete Piles

Eight hundred and forty-four of the piles, 13½ in. square and 25 ft. long, were made in a yard some distance from the bridge and shipped by car to the job, but the remainder of the 2000 were made on the job and hauled to the driver by means of a two-wheeled truck. Each pile contained four ¾-in. round bars placed in the four corners of the square pile and wrapped with a No. 8 wire on a 2-in. pitch. In wrapping the wire on the four bars a 3-in. pipe was used. This pipe had a crank on one end and ½ x 1-in. iron arms bolted at necessary intervals. These were of a length to hold the four rods at the proper distance. The pipe was laid in sockets on trestles. A leather strap was run around the bars at three places to hold them to the arms and then the pipe was revolved, winding the No. 8 wire from the spool to the bars. The wire was then tied to the bars at every third interval to hold the cage intact. Two men at 65 cents per hour and one man at 70 cents per hour made from 16 to 20 cages per day of eight hours.

Some piles were mixed by hand, but the majority were machine made. The mix was 1:2:4. The piles were not rolled under four days and not driven under thirty days. In mixing by hand the board was placed on top of the forms and the concrete shoveled directly into the forms. The cost of concreting by hand and by machine was practically the same, 8 cents per foot of pile, concrete labor being 40 cents per hour.

REINFORCEMENT OF HEADS

Several methods were tried for reinforcing the head of the pile. A mesh of No. 7 wire was wrapped around the head of the pile and concreted in, a richer mix was used, granite screenings were tried and also a cage of $\frac{1}{4}$ x $\frac{1}{2}$-in. iron and an iron spiral of special design. None of these heads would stand the blows of the hammer unless the head was clamped with an outside iron band.

Finally, iron bands $\frac{1}{8}$ x 12 x 12 in. were concreted with the head of three piles and driven without any additional band or clamp. These were so successful that about 1500 piles were then made in this manner. This type gave remarkable results; not one failed in the head in driving.

STORAGE YARD FOR 25-FOOT CONCRETE PILES USED IN VIADUCT

EXPERIENCES WITH PILE DRIVERS

A pile driver was built on the job and a double-acting steam-stroke hammer weighing 5000 lb. was tried. This hammer finally failed, breaking the ram around its entire circumference. The number of piles broken by this hammer was very great. The average number of piles driven per day was nine.

A No. 1 Vulcan hammer, weighing 10,000 lb. with a 5000-lb. ram and $3\frac{1}{2}$-ft. stroke, was used. The blow was delivered by the weight falling $3\frac{1}{2}$ ft., with no steam behind the blow.

This hammer from June 28 to Sept. 8, 1913, drove four hundred and eighty-nine 25-ft. piles in twenty-eight and a half working days, or 17.2 piles per day. From Dec. 4, 1913, to Jan. 1, 1914, it drove 212 35-ft. piles in eighteen and a half working days, without a single pile break of any kind. When a pile drove hard, and there was excessive vibration in the pile and the hammer tended to bounce, the number of blows per minute was reduced to forty.

The cap shown on the opposite page was placed on top of 6 in. of rope cushion on top of the pile, and an oak block 18 in. deep was set in the top of the cap, resting on the iron plate riveted midway in the cap. The hammer was then placed on top of the oak block and the cap fastened to the hammer by a wire cable run through the eyebolts.

CONCRETE PLANTS

Two concrete plants were used—a cableway on the south side and a tower and chutes on the north end. The cableway was a Lambert high-speed outfit, giving 1200 ft. per minute on the traveler and 300 ft. per minute on the hoist. One-yard Lakewood bottom-dump buckets were used. The tower on the north end was built of 6 x 6-in. timbers, 175 ft. high. Insley chutes were used on the top and Wylie chutes at the 100-ft. level. All work within 150 ft. radius of the tower was poured with the lower chutes and beyond that distance with the high-line chutes. A Ransome skip and a two-third cubic yard Smith mixer were used. The speed of the north plant was thirty-five batches, or about 25 cu. yd. per hour, and that of the cableway with a 1-yd. Austin mixer and bucket was about the same. The cost of arranging the chutes and getting ready was more at the north plant than with the cableway, but the chutes were able to pour at night with the same speed as in daylight, while the cableway slowed down to about 20 cu. yd. per hour on night work, and as a result the cost of placing the concrete with the two plants was practically the same. The cost also of setting up the two plants was the same, and the only advantage in the cableway was that of moving heavy materials over the deck and the larger salvage value of the cableway over the chutes.

Gravel, sand and cement were delivered to the two plants in carload lots. The sand and gravel were unloaded from cars by a stiffleg clamshell derrick on a raised platform to two bins over the mixer, the gravel bin holding four cars and the sand bin two. The cement was stored in two bins on either side of the mixer under the gravel and sand bins, on the same elevation as the charging platform. They held two cars of cement. Two men mixed all the concrete. One man controlled the sand, gravel and water and dumped the mixer; the other man carried cement.

The work was done by the Fruin-Colnon Contracting Company, of St. Louis, under the general supervision of Winters Haydock, engineer for the city of St. Louis.

Reducing the Cost of Drainage Excavation

Classification of Contracts Secured a Wide Range of High-Grade Ditch and Canal Work for 7.7 Cents per Cubic Yard

THE reclamation of 488,000 acres of land in the Little River Drainage District (see the Engineering Record of Aug. 22, page 204, and that of Dec. 5, page 612) in the southeastern part of Missouri involves the construction of many miles of flood-water diversion channels and impounding levees and 624 miles of open ditches for local drainage. These require a total excavation of about 42,800,000 cu. yd. of material. In general the material is excavated and deposited in final position at one operation by floating dredges, mainly of the dipper type, at an average contract price of 7.7 cents per cubic yard, exclusive of the cost of clearing the land. The work is located in a territory averaging 10 miles wide and 90 miles long, most of which is continually or frequently submerged and is covered with a heavy second growth of timber. There is a wide variation in the dimensions of the ditches and channels, which range in bottom width from 4 to 123 ft. and in depth up to 12 ft. Much of the work is too small for large dredges and too large for small ones to handle to the best advantage. Notwithstanding these conditions, prices satisfactory to the supervisors were obtained, chiefly through the method employed of classifying the work and arranging the contracts so that they could be handled advantageously and be adapted to continuous work by given units of plants. The fact that dipper dredges could be used for a large part of the excavation helped keep the cost down.

The diversion work, consisting of deep wide channels and high levees, involved 8,621,591 cu. yd. of estimated excavation. The bulk of it was divided into two nearly equal contracts. The local drainage work involved about 34,208,101 cu. yd. of estimated excavation and was divided into twenty-seven contracts, awarded to twelve different bidders.

GOVERNING CONSIDERATIONS

The classification and allotment of contracts was governed as much as possible by five principal considerations—(1) division of the work into units with channels dimensions particularly adapted to a standard type of machine, (2) allotment of sufficient yardage to each contract to give at least $2\frac{1}{2}$ years' work to a suitable machine and thus make the contract attractive, (3) location of an accessible building site on some railroad at or near the head of each contract, (4) provision for uninterrupted transportation of fuel to the excavating machines and (5) elimination, as far as possible, of all upstream work.

The $2\frac{1}{2}$-year duration of contracts was unobjectionable for the small work. On the large work, where the bottom widths range from 81 to 123 ft., there is required a $4\frac{1}{2}$-yd. excavating bucket and a 100-ft. boom which, with its supplementary equipment will cost from \$40,000 to \$75,000, and in order to reduce the cost per yard to reasonable limits an amount of work is required that necessitates the continuous operation of the plant for a long time. For these contracts this time was figured at three years, except in one instance where other conditions made the necessity of completion of the work remote, so that the time could be extended to forty months.

The transportation of fuel was in some cases difficult, because as the work progresses from its origin, unless some perpetual stream is tapped, the water level in the ditch is lowered uniformly during the dry season. The effect of this is long continuous work is that the contract must be provided at least once in every 5 miles with an accessible base for the transportation of supplies.

COMBINATION OF CONTRACTS

In classifying drainage bids there is great advantage in dividing the work into contracts before making the estimates of cost, because the combinations of different classes of work greatly modify their unit costs. For instance, a canal with a bottom width of 4 ft. is, independently, 8-cent work, but when it is necessary, as it often happens, to place such work in the same contract with ditches having 25-ft. bottom widths, the cost of the 4-ft. width is much increased because the required width of barge for a dredge suitable to excavate the 25-ft. width will be much greater than that for the 4-ft. width and will necessitate a considerable amount of excess excavation.

After the drainage ditches were divided into contracts they were assembled into bidding sections including from 4,000,000 to 6,000,000 cu. yd. each. Both sealed and open proposals were invited and the former were of course filed before the latter were received. Bids were asked for combinations of work as follows: (1) On an individual contract, (2) on a combination of two or more contracts, (3) on an individual section, (4) on a combination of two or more sections, (5) on all the drainage canals, (6) on the entire headwater diversion and (7) on the entire work. These invitations elicited 466 open bids and nineteen sealed bids for the contracts, three open and four sealed bids for the sections, one sealed bid for the entire work and six open bids for combinations of contracts, making a total of 475 open bids and twenty-five sealed bids or an average of seventeen bids per contract.

The same division of contracts was applied to the diversion work as to the drainage ditches, the work being divided into two practically equal parts in order to secure what were considered good contracts.

The bids received were unbalanced on account of the contractors' wish to secure a comparatively large payment for clearing at an early stage of the work, but as this work was restricted and the bids were considered good as a whole they were accepted. The bids for clearing and grubbing on the diversion work varied from $65 to $100 an acre, as compared with a uniform price of $20 an acre for the drainage work. The channel and levee-work bids varied from 7½ to 16 cents per cubic yard.

The work is well under way and is being executed by the Board of Supervisors, of which William A. O'Brien is chief engineer, and Isham Randolph, consulting engineer.

THE AJAX, one of the two 250-ton floating cranes for the Panama Canal ordered from Deutsche Maschinenfabrik Actiengesellschaft, of Duisburg, Germany, was placed in service recently.

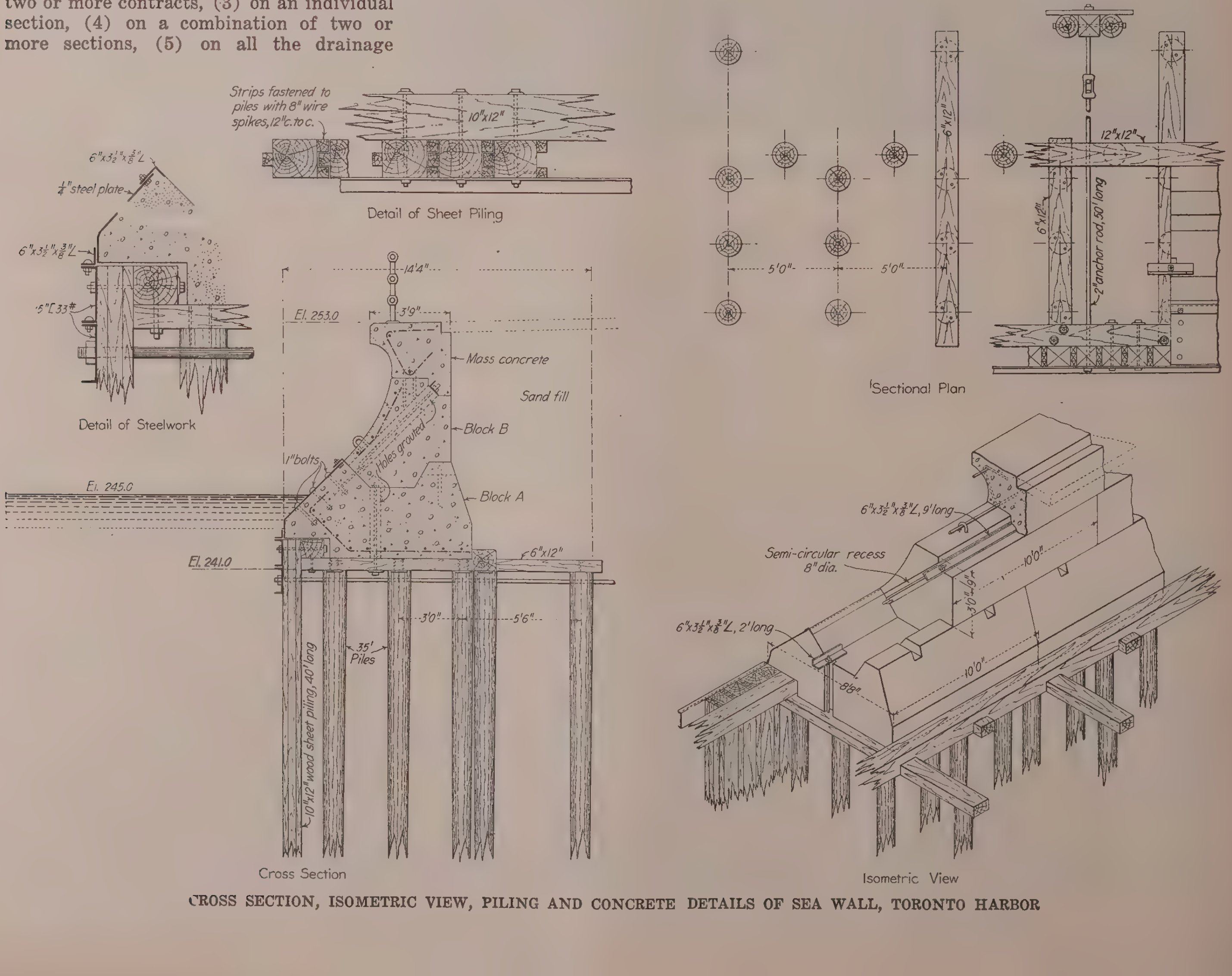
Toronto Breakwater to Curb 10-Foot Waves

Heavy Concrete Blocks Molded Separately, to Be Set in Walls by Cranes and Capped with Mass Concrete, as Part of $19,000,000 Waterfront Improvement

TORONTO is now engaged in building harbor works, estimated to cost $19,000,000, which include an elaborate system of docks, an industrial section with 646 acres available for factory sites and a boulevard and park development extending over a distance of 14 mi. The principal features of this work were described in the Engineering Record of Sept. 19, page 326.

In this article some details of the breakwater and sea-wall designs will be taken up. The chief feature in these structures is the use of separately molded concrete blocks, placed by cranes and capped with mass concrete. Steel protection plates to prevent destruction of the lower part of the concrete by ice are an additional feature.

As fully described in the article above referred to the breakwater and sea-wall construction may be classified in three divisions. First, there is the breakwater, extending from the western channel entrance to the harbor westward to the mouth of the Humber River and located from 500 to 900 ft. from the present shore line. A lagoon will thus be formed. The second division is a sea-wall running eastward from the eastern entrance to the harbor to the eastern end of the development. Immediately back of it will be a boulevard and a park



CROSS SECTION, ISOMETRIC VIEW, PILING AND CONCRETE DETAILS OF SEA WALL, TORONTO HARBOR area, so that the problem of preventing the overtopping of the wall by waves entered here, though it did not in the breakwater design. The third division of the work consists of the walls along the channel and turning basin within the industrial district. Here the wave problem was negligible and wharfage the chief consideration. Three distinctly different conditions, therefore, had to be met and the designs, as will be seen from the description below and from the drawings, have been modified accordingly.

DESIGN ASSUMPTIONS

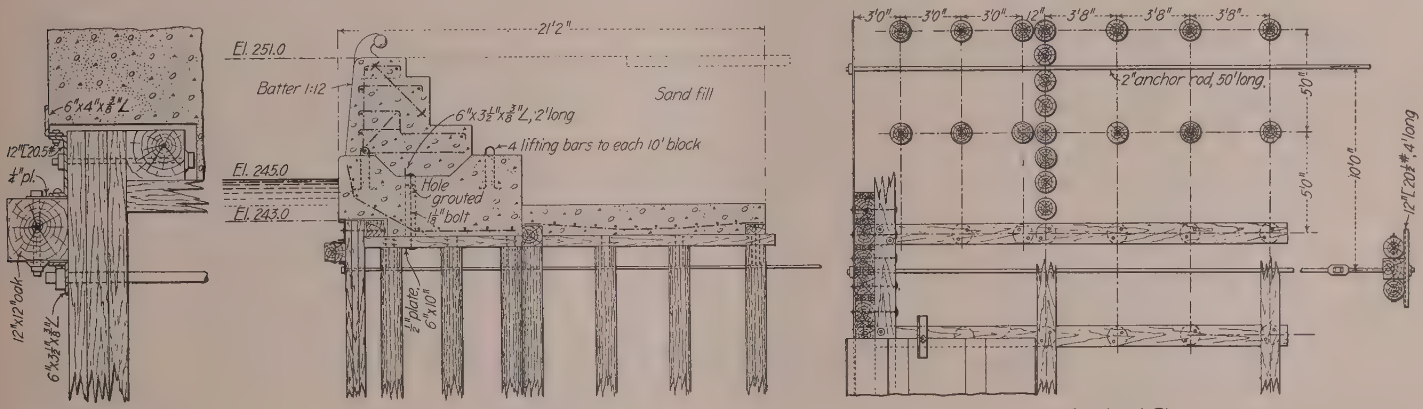
Observations at Toronto indicate that waves between 7 and 8 ft. high are to be expected. In designing the new work, however, a 10-ft. wave, imposing a blow of 1000 lb. per square foot on the breakwater masonry, was assumed. With this figure both the shearing and overturning forces were investigated and the design given an ample factor of safety. Careful investigation was made, also, into breakwater designs used elsewhere and the experiences were all given consideration in the adoption of the Toronto sections.

DETAILS OF BREAKWATER

An accompanying drawing gives the details of the breakwater so fully that little description is needed. The proposed structure consists essentially of a rock-filled timber crib capped with concrete. Blocks *A*, *B* and *C*, weighing respectively 12.7, 6 and 5 tons, are to be cast at any point found suitable by the contractor and are to be placed when fully cured. Their reinforcement and anchorage are plainly shown on the drawing. The final block is of mass concrete.

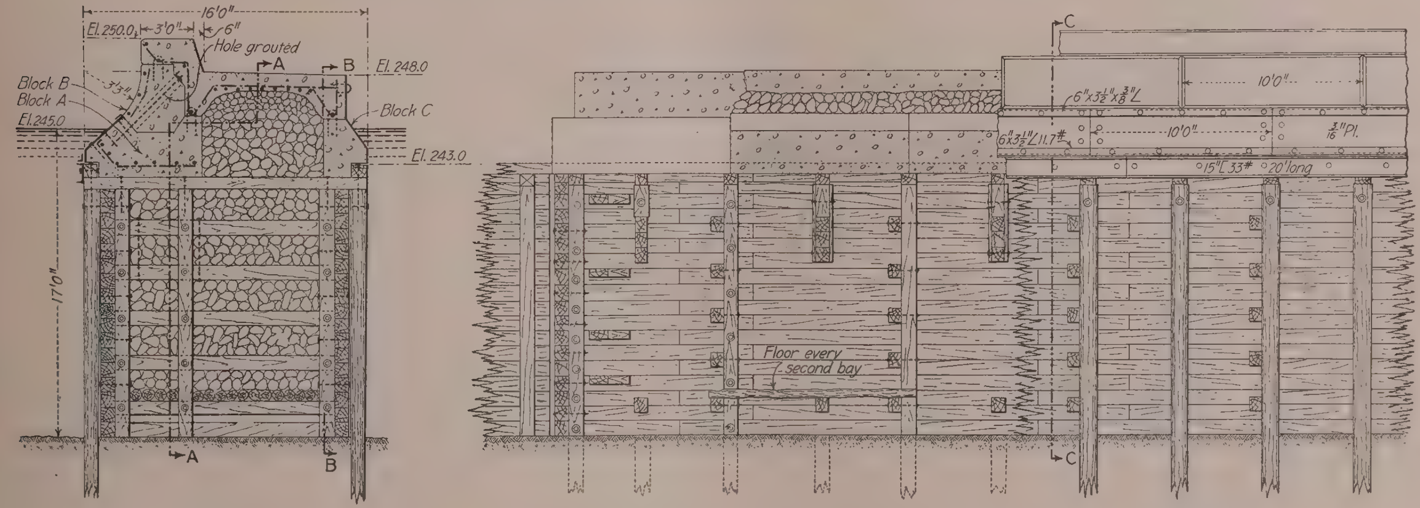
The steel protection on the front of block *A* is especially interesting. Its position, evidently, affords a safeguard against damage to the lower part of the structure by ice.

Details of the sea-wall design are shown quite fully in the drawings. As in the breakwater section the lower blocks, *A* and *B*, weighing respectively 21 and 12 tons, are to be cast separately and to be set when cured. The top, however, is to be of mass concrete. Two points in this design are worthy of special attention, the steel protection of the lowest block and of the upper part of the sheet piling, and the curve at the top of the wall, designed to throw the wave outward, and prevent it from overtopping the structure and washing out the roadway behind. The top will be about 8 ft. above ordinary datum. Heavy riprap will be deposited along the toe forming a protection for the sheet piling and serving to retain the fill surrounding the piles supporting the sea-wall.

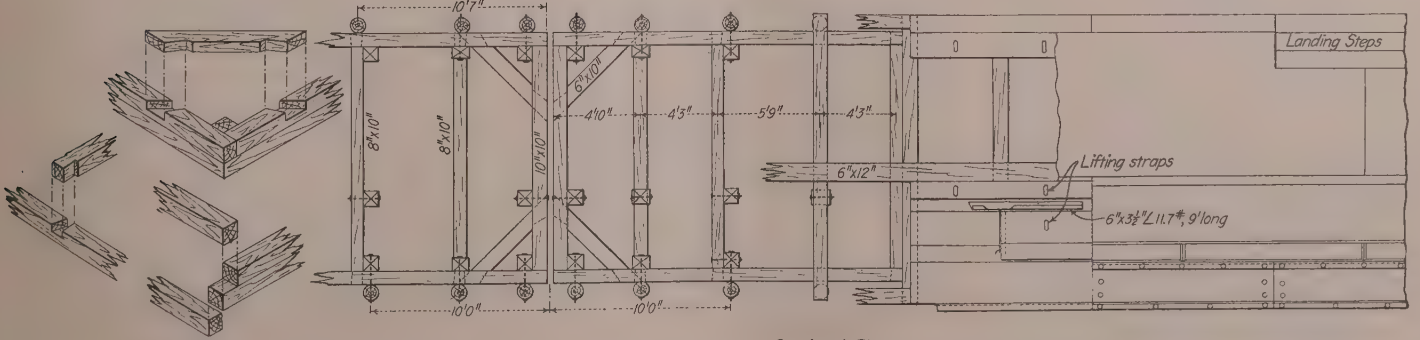


Detail of Steelwork Cross Section Sectional Plan

CROSS SECTION, DETAIL OF STEELWORK AT TOP OF SHEET PILING AND PLAN OF SHIP CHANNEL WALL



Section C-C Section B-B Section A-A Front Elevation



Detail of Crib Sectional Plan

CROSS SECTION, ELEVATION, PLAN AND DETAIL OF BREAKWATER, TORONTO HARBOR

An accompanying drawing shows the details of the wall for the ship channel. Special attention should be called to the attachment of the oak waling strip near the top of the timber sheet piling.

GENERAL QUANTITIES

The specifications for all the concrete work call for a 1:2:4 gravel or crushed stone mixture, the aggregates being graded to secure maximum density. The timber bill for all of this work will run very high. Approximately 2,000,000 linear feet of round bearing piles will be required and 20,000,000 ft.b.m. of other timbers, consisting mainly of hemlock and longleaf yellow pine or Douglas fir. The molded concrete blocks will total about 73,000 cu. yd. and the mass concrete 50,000 cu. yd.

The breakwater, sea-wall and walls for the channel and turning basin are being built by the Dominion Government in cooperation with the Toronto Harbor Commissioners. The contract price approximates $5,400,000 and the award was made some time ago to the Canadian Stewart Company, the Canadian branch of James Stewart & Company, of New York. The engineering work of the Harbor Commissioners is being carried out under the direction of E. L. Cousins, chief engineer, and J. R. Wainwright, assistant chief engineer.

The Yukon River

THE Yukon River in Alaska is one of the great rivers of the North American continent. A brief report on its discharge at Eagle, Alaska, has just been issued by the U. S. Geological Survey as Water-Supply Paper 345-F. The river is given the fifth place among the large rivers in North America and its drainage area is estimated at about 330,000 sq. mi. Its length, including the Lewes and Teslin rivers, is given as 3200 mi. This may be compared with 6000 mi. for the Mississippi and Missouri, 2868 mi. for the Mackenzie, 2000 for the Colorado combined with Green River, and 1300 for the Ohio combined with the Allegheny.

The discharge of the Yukon varies from a maximum of 254,000 to a minimum of 10,100 sec.-ft., with an estimated average of 73,200. This is a relatively small discharge, the average flow of the Mississippi being 695,000, that of the Ohio 300,000, and that of the Colorado 23,300 sec.-ft. The Nile, with a drainage area of 1,262,000 sq. mi., has an average flow of 116,000 sec.-ft. The flow of the Yukon is, therefore, small as compared with its drainage area, which is accounted for by the fact that the interior of Alaska has the small rainfall characteristic of that portion of the United States which lies between the Sierra Nevada and the Rocky Mountains, north of the latitude of Salt Lake City.

MANGANESE-REMOVING ALGÆ have been developed in the water supply of Dresden, Germany, which is obtained from wells and causes trouble from a black deposition of manganese. Two sets of filters are used, stated Dr. Edward Bartow in a recent paper read before the Illinois Section of the American Waterworks Association—one a gravity system containing the algæ and the other pressure filters depending on manganese permutit for their action. While both processes work, the manganese removing organism makes the gravity system the more economical.

Accommodations de Luxe for Federal Valuation Engineers

An Account of the Manner in Which Uncle Sam Is Taking Care of Some of the Men in Remodeled Pullman Car Homes

AFTER wrestling with the broader administrative problems involved in initiating the Interstate Commerce Commission's valuation of the common carriers of the United States, the members of the Engineering Board turned their attention to what might be called details if upon their proper solution did not so largely rest the success or failure of the whole undertaking. Among the questions was that of taking care of the men who were actually to inventory the railroads' property. It was at once realized by all concerned that unless subsistence for the men could be provided in a way that would entail no hardship upon them the real esprit de corps so essential to the accomplishment of any object involving the labor of many hands and minds could not be developed. Few men can give the best of service when subjected to annoyance and inconvenience in what might be called their "home life." To get men to put their hearts into the work at hand you must put something into their stomachs other than the boiled potatoes, cabbage, "sowbelly," and sloppy coffee usually found in way-station "eating houses." No matter how remunerative from a monetary standpoint the positions to be filled might be made, experienced and efficient men accustomed to the comforts of life at larger railway points could not be expected to devote themselves with any degree of permanency to work entailing many of the discomforts of a construction gang or a lumber camp.

In connection with this question there was to be considered the ever-present one of economy, for with hundreds of men in the field even a small waste in caring for the individual member of a party would aggregate large.

DIVISION OF WORK

As far as practicable the members of the Engineering Board have grouped the valuation field forces to conform to the construction and maintenance organization of railways. Thus the mechanical department of each district will value rolling stock, shop machinery, and tools, etc., the structural department will inventory the larger bridges and buildings, the telegraph department will appraise wire equipment, and an engineer of experience will have charge of the inventorying of signal systems. Each of the mechanical, structural, and telegraph parties consists of only two or three men. From the nature of their work much faster progress can be made than by the road-and-track field parties, and consequently they would be subjected to much less discomfort. The subsistence difficulty, therefore, is confined to the roadway parties.

The roadway parties consist of the chief (officially designated "second assistant field engineer"), recorder, computer, assistant computer, instrumentman, rodman, head chainman, rear chainman and tapeman—all civil-service employees. With each such party is a representative of the carrier's engineering department, who serves in a dual capacity as a "pilot" and as a guardian of the carrier's interests, insuring a complete inventory and an accurate recording of the physical facts.

This article has to do solely with the Western District. The first party placed in the field in the district, which embraces North Dakota, South Dakota, Nebraska, Colorado, Kansas, Missouri, Oklahoma and Texas, began work on the Texas Midland Railroad, which extends from Paris to Ennis, Texas. This was in January, 1914. As an experiment the men were kept at boarding houses and hotels in the towns along the line, and the result was such as fully to confirm the opinion of the members of the Engineering Board that this method would not be desirable from either the standpoint of efficiency or that of economy. Not only was it expensive, but the men failed a large part of the time to find even passable living accommodations. Their hours of work were dependent upon the train schedule of the carrier and much time was lost on that account. "Speeders" could not be utilized for the transportation of the men, because it was felt that their use would, to a certain extent, jeopardize and make extra-hazardous the lives of the employees.

USE OF REMODELED PULLMANS

From this preliminary experience a method was evolved which has given satisfaction to all concerned. After careful consideration and several conferences a plan for the remodeling of Pullman cars was decided upon which embodied every possible comfort and convenience for housing the men composing the field parties. Even a shower bath is provided, and it has proved almost indispensable. A contract of sale was entered into with the Pullman Company, and all of the districts have been supplied with the "outfit cars." The plan shown furnishes a better idea of their arrangement than an extended description.

Before delivery of any of these cars could be made the second field party of the Western District was organized and placed on the Kansas City Southern's line. To house these men an old coach and two box cars were rented from the carrier and made habitable by building partitions, tables, cupboards, etc., and installing double-deck iron cots and other needed furniture. Where country was traversed in which good drinking water was unobtainable a tank car was added to the outfit. The use of this outfit will terminate with the completion of the party's work on the Kansas City Southern.

Pending the delivery of the remodeled Pullman cars three outfits, each consisting of two 50-ft. mail coaches, were rented from the Great Northern Railway. These were found so adaptable to the purpose that the commission purchased them from the railroad. The plan of these is also shown.

A regular form is provided, upon which the chief of party, at least twenty-four hours in advance, requests the carrier to move the car from one station to another, or, if more convenient for working purposes, to an intermediate siding. For each of the men in the cars when moved the regular passenger-tariff fare is paid. The commission has not yet decided what is a reasonable charge for the moving of the cars, but when the rate is determined settlement will be made with the carriers. A record is kept of all outfit-car movements. Trainmen are instructed to handle the cars with great care, and not to move them at all in the night unless absolutely necessary.

EXPENSE

In addition to his salary each civil service employee connected with a field party, except the chief, receives $1 a day to cover subsistence expenses. The chief is allowed a per diem of $1.50, as he incurs expenses in the course of his duties to which subordinates are not subject. The Commission pays the wages of a cook and a laborer, the latter usually assisting both in the field and about the car. Where the work in the field is very heavy a flunkey is sometimes hired to help about the car, while the laborer works in the field. The laborers receive $2 a day, and out of their wages must pay the party for subsistence. The expense of the cook's subsistence, and the flunkey's (if there is one), is borne by the members of the party. The carrier's representative is charged a fixed sum by the party for subsistence.

The men's per-diem allowance is handled by the chief of party, who keeps an accurate record of all receipts and disbursements, and accounts to the men for any cash surplus or overstock of supplies. With the allowance the men pay for all food, water, fuel, oil, ice and laundry work. Table and bed linen, blankets, cutlery, kitchen utensils, chinaware, etc., are included in the outfit furnished by the Commission. Staple articles such as canned goods, potatoes, flour, etc., are purchased at wholesale prices in the larger towns along the line by the chief of party. Meat, butter, eggs and other perishable food are bought locally.

GENERAL INFORMATION REQUIRED

Before work is begun on a valuation section the carrier is required to furnish, among other data, a statement showing the population of the towns, the condition of the water along the line, the mail and telegraph facilities, etc. This enables the chief of party to plan the movements of the outfit with discrimination. On the daily reports of work accomplished by the party, which he sends to the district office, is given the name of the town at which mail will reach the party several days later—and the large amount of personal mail forwarded through the district office indicates that the men in the field are not wholly isolated from their homes and friends.

The following is a typical day from the life of the men in one of the field parties. Arising about 6 or 6.30 a. m. (depending on the distance of the car from the point where work for the day is to begin), the men have dressed, washed, made their beds and swept out the car within half an hour. Then they devote their best efforts to a breakfast consisting of grape fruit, puffed rice, ham, scrambled eggs, fried pototoes, wheat cakes with syrup, tea, coffee, or cocoa, and bread and butter.

Eight hours constitute a day's work, and this does not include the time spent going to or returning from work. The computer and assistant computer remain in the car, and the balance of the party is formed into groups: The chaining group, composed of the recorder, head chainman and rear chainman; the ballast group, made up of the chief of party, carrier's representative, and laborer, and the cross-section group, which includes the instrumentman, rodman and tapeman. Of course these groups are not maintained throughout the entire course of the work, as men are constantly detached from one to help another. Ties, fence posts and rails, steel rails, frogs, etc., are counted; embankments and cuts are measured and classified, ballast is trenched and an accurate inventory made of every other physical item along the right of way, with the exception of the larger structures and rolling stock, which are left to the structural and mechanical departments, and the telegraph equipment, which is taken by another department. The value of the land forming the right of way is being ascertained by the Land Department.

On rainy days the entire party works on computations and notes. At such times the laborer does odd jobs about the car calculated to add to the comfort and convenience of the party.

If the party has not progressed too far from the car by noon (the parties completely inventory, on an average, 2½ mi. per day, but often partially cover 5 mi. in a single day) the men return there for lunch; otherwise, the laborer or cook brings out water, ham sandwiches, cake, pie, oranges and apples. All the men are supplied with army canteens.

By nightfall the men are ready to make another attack upon the commissary department. As soon as they have washed, the cook sets before them soup, roast beef or a T-bone steak, mashed or baked potatoes, stewed tomatoes, baked beans, tea or coffee, pie, cake and preserved peaches or sliced pineapple. The only thing missing is the "after-dinner cigar," for the regulations prohibit smoking in quarters and during working hours. No employee is allowed to use intoxicants at any time; gambling and the use of unseemly language are also under the ban. These regulations are mere precautions, as the men have proved to be a clean, wholesome lot.

EVENINGS AND SUNDAYS

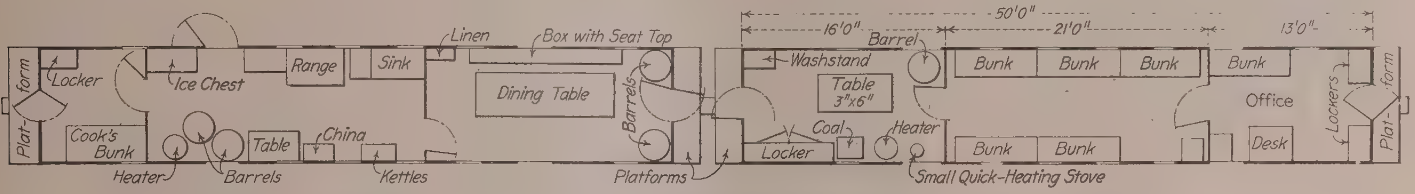
Occasionally the men will do a little office work in the evening, but mainly they devote this time to playing chess or cards, writing letters, reading books or technical and fiction magazines, playing baseball, talking or joining in "barber shop" melody. Baseball teams, organized by some of the parties during the past summer, played match games with the "Champeens" of the towns at which the cars stopped. Several of the parties have purchased fine phonographs and records with a surplus from the per-diem allowance. A circulating library for all the parties will soon be established by the men.

On Sundays those who feel so inclined have ample opportunity to attend church, as the outfit is usually in the yards of some village or city. Walks through town or strolls through the country are taken, especially by those who find amusement in photography. Those in the party who have not been long out of college usually do not find enough time during the week to reply to all the letters written in a feminine hand which they receive, and Sunday is spent in sedulous literary endeavor. Fishing and hunting are also enjoyed.

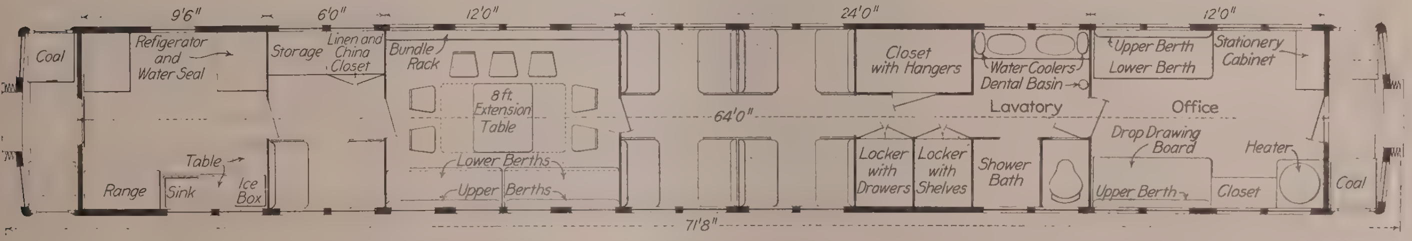
During thre months of the summer Saturday afternoon is a holiday. Two weeks vacation with pay will be granted practically all of the men at Christmas time. In addition a man absent from work not more than thirty days during the year because of sickness receives full pay for the time that he is incapacitated.

Most of the men are about the same age, and they form a very congenial group. The efficiency of the work is largely attributable to the harmonious relations existing between the members of the parties. One thing that gratifies an observer is the very apparent interest of the men in their work.

To safeguard the health of the men, wherever there is the slightest doubt about the quality of the water distilled water is purchased. The Commission furnishes to



TEMPORARY QUARTERS PROVIDED IN TWO MAIL COACHES RENTED FROM THE GREAT NORTHERN RAILWAY



PLAN OF PULLMAN CAR REMODELED TO PROVIDE COMFORTABLE LIVING AND OFFICE ACCOMMODATIONS each employee free of cost (through the courtesy of the War Department) typhoid antitoxin. The toilets on the cars are not used. Emergency medical cabinets form a part of the equipment of each outfit. So far, however, there has not been a single serious accident or case of sickness. Plans are under way to form a mutual relief association, for the care of field employees who meet with accident or are stricken with disease.

Perhaps the best commentary upon the Government's care of its employees engaged in the valuation work is furnished by the fact that since the parties were first placed in the field by the Western District only one man has resigned. If experience of its employees is of any value in accomplishing the task set before the Interstate Commerce Commission, the job apparently will be well done.

The Western District is under the supervision of John S. Worley, member of the Engineering Board of the Interstate Commerce Commission. His office is at Kansas City. The information on which this article is based was obtained from O. H. Brinkman, chief clerk in the Kansas City office.

Sewers Cleaned with Scrapers to Pass Ball Test

Methods and Costs of Work, Involving Pipe from 8 to 18 Inches in Diameter, at Carlisle, Pa.

By CLARK A. BRYAN
Resident Engineer, Sewerage Commission,
Carlisle, Pa.

CHOKED with débris carried into them by storms, while still under construction, 7.3 miles of sewers at Carlisle, Pa., varying in size from 8 to 18 in., were cleaned by a scraper until wooden balls, 2-in. smaller in diameter than the sewer itself, could be passed through the line, as required by the specifications.

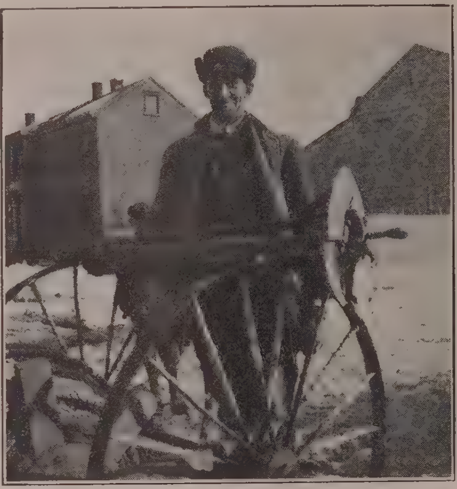
The apparatus was all home-made. Two Ransome concrete carts were dismantled, the hoppers removed and replaced with wooden frames, 6 ft. 9 in. long and 2 ft. wide, which carried three reels for the rope used in hauling the scraper through the sewers. On the largest drum about 425 lin. ft. of ¾-in. rope was coiled; this amount was required to reach between any two manholes on the system. The small drums carried lighter lines, one having 425 ft. of ¼-in. rope, and the other about 1000 ft. of stout fishing line.

SEWER SCRAPER

For the device used to clean the sewers a piece of iron pipe 3 ft. long was taken and at one end two pairs of semicircular iron bands or clamps were attached as shown in the photograph.

The method of operation was as follows: One of the carriages was set up over a manhole in the block to be tested, and the other carriage was stationed at the next manhole downstream. Water from the city mains was then turned into the sewer at some point above and it was found that a depth of 2 in. of water in the sewer was necessary for carrying on the work. An empty bottle or flask was next attached to a fishing line and floated through the sewer to the downstream manhole at which point it was withdrawn. To this end of the fishing line the ¼-in. rope was attached and the line then wound up on its drum at the upstream manhole. After the ¼-in. rope had been pulled through the section the ¾-in. rope was likewise attached to it at the lower manhole and in its turn was pulled to the upper one. The scraper was then put into the sewer at the upper manhole and one end attached to the rope that had just been pulled through the sewer. The other end was attached to a similar rope coiled up on the large drum on the carriage at the manhole. The scraper was then drawn downstream through the sewer by winding up the ¾-in. rope on its drum at the downstream manhole. If the scraper stuck in its passage through the sewer it could generally be loosened by pulling it a short distance upstream towards the manhole at which it was introduced. Then it started once more on its downstream journey.

To prevent the rope from wearing out from friction against the edges of the pipes in the manholes and also against the edges of the iron manhole covers, 3-in iron sheaves were let into 4x4-in. braces, which were placed at the top and bottom of each manhole and securely wedged into place.



SEWER SCRAPER

PARACHUTE ROPE DRAG

It was found that the method of floating a bottle or flask through the sewer was both laborious and unsatisfactory as the flasks were frequently broken. A sort of parachute was therefore devised which worked better because it was found that the parachute could drag the ¼-in. rope through the sewer and thus do away with the necessity of first using the light line. This parachute was made out of oil-cloth and the rope was attached to it at its throat.

To prevent the passage of mud, sticks and stones through the sewer a funnel-shaped screen made of ½-in. mesh wire was placed in the low side of every manhole on the line. This screen was further securely wired to the manhole in which it was inserted in order to prevent its being compressed by the rush of water and drawn into the sewer. It was observed that these screens choked easily and that they greatly retarded the flow of water through the main. At the same time they prevented solid materials from passing through the sewer and when once clogged they also served to retain much of the mud and silt in the manhole.

If necessary the scraper was pulled through a section several times and the testing ball was not allowed to pass through the line until the inspector was satisfied that it was clear. As a result of these precautions the ball did not become lodged in the sewer during the entire test.

In some of the sewers empty cement bags were found and a set of sewer cleaning rods was made. These rods were made of ½-in. iron pipe cut into 4-ft. lengths and having a thread cut on each end of each length. A ½-in. coupling was also provided with each length. The bags were removed by using a large hook attached to the end of these rods.

In general it was only necessary to pull the scraper through each section once; in some few instances, however, the main had become badly clogged with dirt and it required considerable labor and time to remove it. The scraper was found to be quite efficient and would remove stones or cement that had adhered to the sides of the pipe without much difficulty. In one instance the sewer was found to be clogged with large stones, but by using an automobile as the source of motive power the scraper easily removed them.

ORGANIZATION AND COSTS

The organization employed in cleaning the sewers was composed of a foreman and three or four laborers, depending upon circumstances. The work was started on Jan. 19, 1914, and was finished Feb. 16. The total length of sewers cleaned amounted to 38,500 lin. ft., or an average of 1375 lin. ft. per day of 9 hours. It should be noted that there is included in this about 12,500 lin. ft. of sewer, practically all of which was 8-in. pipe and which was built by a subcontractor and was all tested in two days' time.

Table 1 shows the itemized cost of this work.

Regarding this work the writer is of the opinion that the greater part of the money spent in testing the sewers was spent unnecessarily by the contractor. Had he taken the proper precautions to protect his work from the entrance of dirt and stones

TABLE 1—ITEMIZED COSTS OF SEWER CLEANING

LABOR	
260 hrs. foreman @ $0.35	$91.00
30 hrs. foreman @ 0.40	12.00
850 hrs. labor @ 0.175	148,75
20 hrs. pumping @ 0.175	3.50
Total labor cost	$255.25
MATERIALS	
5 wooden balls	$21.00
Paint and repair balls	2.50
1300 lin. ft. ¾-in. rope	28.60
1300 lin. ft. ¼-in. rope	7.80
1000 lin. ft. twine	0.75
2 concrete buggies	20.00
425 lin. ft. sewer cleaning rods	$21.25
1 iron scraper for sewers, 8 in., 10 in. and 12 in., incl. 25 hrs. blacksmith's time @ $0.30	12.00
1 iron scraper for sewers 15 in. and 18 in. in size, incl. 40 hrs. blacksmith's time @ $0.40	20.00
Sheaves and blocking	2.00
Lanterns, etc.	3.50
Miscellaneous supplies	3.00
975,000 gal. of water used in cleaning operations	48.75
Total cost of materials	$191.15
Total cost to contractor for testing	$446.40
Total cost of testing per lin. ft. of sewer	1⅛ cents

TABLE 2—SUBCONTRACTORS SEWER CLEANING COSTS

LABOR	
30 hours foreman @ $0.40	$12.00
60 hours labor @ 0.175	10.50
Total cost of labor	$22.50
MATERIALS	
1 wooden ball, 6 in. diam.	$3.00
Rope	2.50
Water (— gals.)	2.50
Total cost of materials	$8.00
Total cost of work	$30.50
Cost per lin. ft. about	¼ cent

during construction the expense would have been but a small proportion of the above. This conclusion is well born out by considering the expense to which the sub-contractor was put to clean and test his lines and which is itemized in Table 2.

The work of testing this portion of the system was carried out at the rate of approximately 5000 lin. ft. per day and the difference that the unit cost of testing this portion of the system bears to the cost of cleaning the entire system is so marked as to deserve attention.

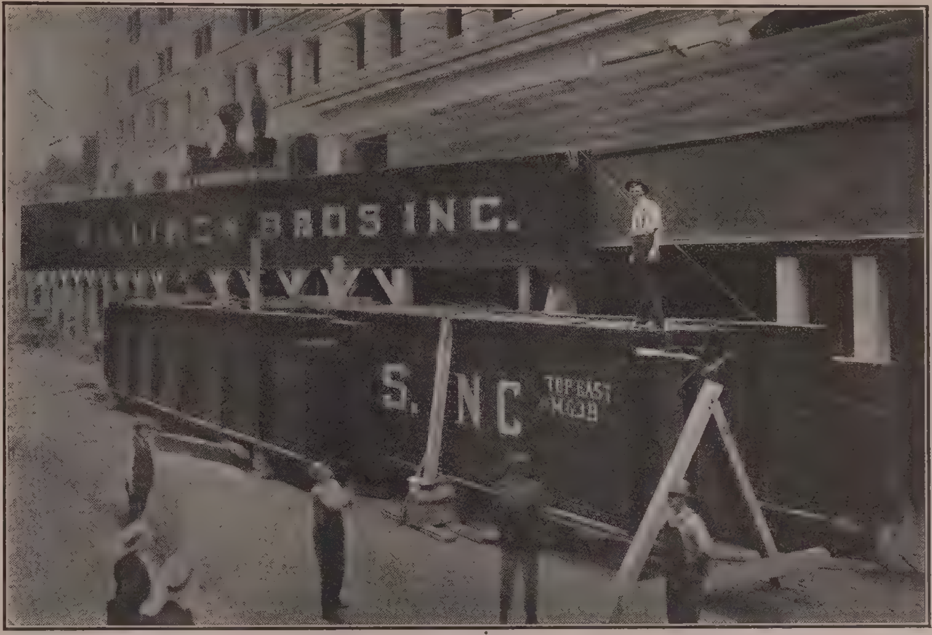
REMEDIES FOR CLOGGED SEWERS

It is evident that it will pay a contractor to give considerable time and attention to the question of keeping his pipe lines free from dirt and other foreign substances that will tend to clog them. The following suggestions are offered as a partial solution of this problem:

Construct all manholes as soon as possible after all pipes entering them have been laid, and set the iron frame and cover at this time. In the case of junction manholes plug all pipes entering the manhole with substantial tapered wooden plugs which should be well braced to the sides of the manhole. Wherever possible the pipe should be laid continuously through the manhole, the concrete or brick bottom then built about it and the top half of the pipe removed by a chisel only when the system is ready for acceptance. It has been shown on this work that on those sections where these ideas were carried out foreign substances were prevented from getting into the main and the labor necessary to clean them out previous to testing was reduced to a minimum.

The contract for the construction of these sewers was awarded to the H. C. Brooks Company, Inc., of Martinsburg, W. Va. H. M. Sherwood has been superintendent of construction and the writer the resident engineer in charge of the work. The scraper used to clean the mains was built along lines outlined by Mr. Sherwood.

CLEANING A 27-YEAR-OLD SEWER AT Manistee, Mich., obviated the necessity of rebuilding a section of 4 ft. in diameter for which the city was about to issue bonds for $30,000 when the city-manager form of government went into operation. Carl E. Ruger, at the City Managers' Conference in Springfield Dec. 3, stated that 1102 tons of sand and refuse were removed from the conduit at a cost of $1200. After cleaning the various branches the system was found adequate, hence the manager has postponed indefinitely the necessity for the bond issue.

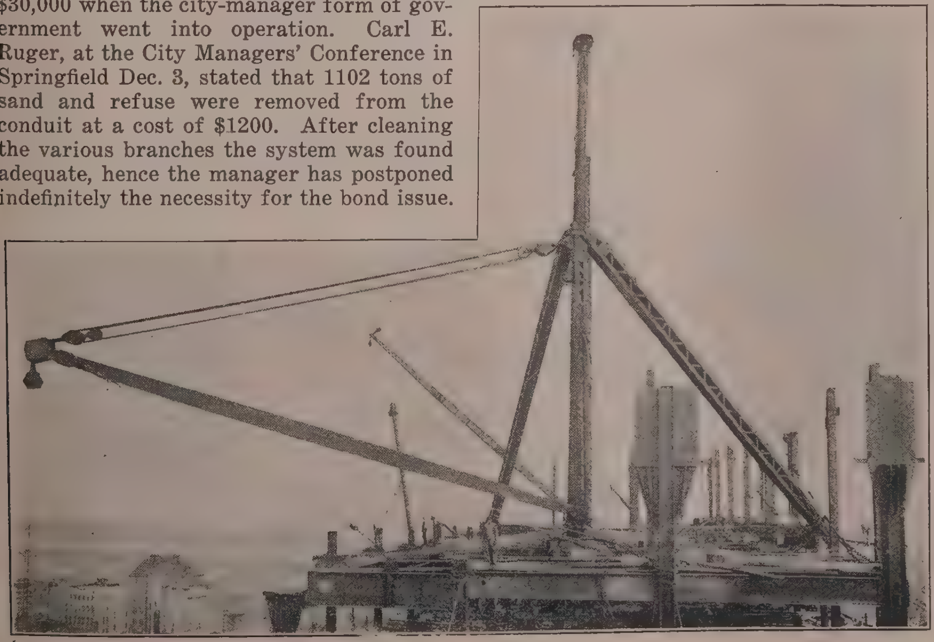


COMMENCING TO HOIST 40-TON GIRDER FROM THE STREET WITH DERRICK ON ROOF

Erecting 40-Ton Girders at a Height of 250 Feet Above the Street

Method of Hoisting with a Single Derrick a Number of 62-Foot Plate Girders over the Roof of an Occupied Twelve-Story Building

SEVEN new floors of the nineteen-story office-building of the Consolidated Gas Company, of New York, at Fifteenth Street and Irving Place, are suspended from eight plate girders spanning the old twelve-story part of the building from new steelwork each side of the old structure. The girders were hoisted from the street and swung to position far above the occupied building by a single 80-ton steel derrick located near the top of the new steelwork. Special provisions were made for the distribution and support of the concentrated derrick loads and for the temporary girder-hoisting attachments. The present nineteen-story structure has a front nearly 300 ft. long, built on both sides of, and including, a former twelve-story building 150 ft. high with a 62-ft. front. The new building incloses the old building and required the addition of seven stories above the latter, which was occupied by a large force of employees during the construction of the new building.



DERRICK INSTALLED 200 FEET ABOVE STREET TO HOIST 40-TON GIRDERS

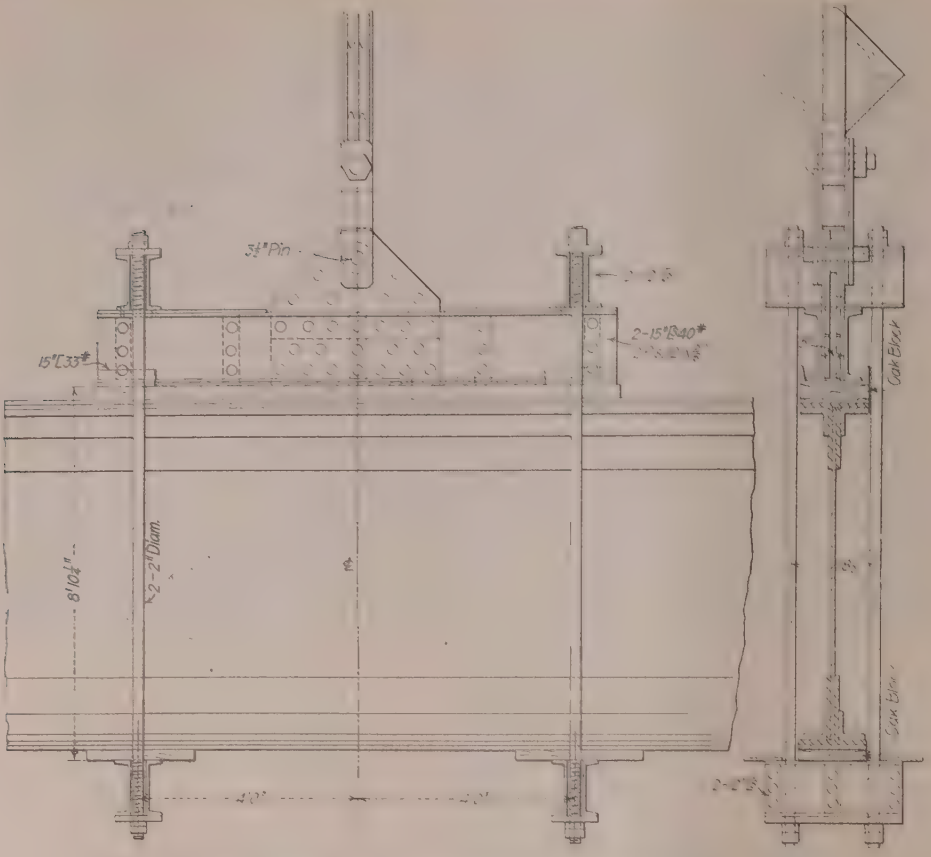
COLUMN AND GIRDER CONSTRUCTION

As the foundations and columns of the old buildings were not designed for additional stories, the latter are carried by new columns located close to the old columns in the side walls of the old building, with foundations on rock. In each of two rows there are five of these columns 250 ft. high. They project 100 ft. above the top of the old roof and 18 ft. above the upper floor of the new building. Plate girders 8 ft. 4 in. deep span the width of the existing building and are field-riveted to deep gusset plates at the tops of these columns, and from them the seven upper floors added to the old building are suspended.

Pairs of 40-ton girders 62 ft. long connect the three columns nearest the front of the building on one side to the corresponding columns on the opposite side, and receive vertical riveted suspenders connected to diaphragms joining the webs of both girders. In the rear of the building, on account of the space provided on one side for an exterior light shaft, the two rows of wall columns are only 43 ft. apart, and are connected by single 30-ton plate girders 43 ft. long.

ERECTION OF GIRDERS

For erecting the girders there was employed a special steel stiffleg derrick of 80-ton capacity, having a 71-ft. boom. It was located on the nineteenth floor of the new part of the building, where it commanded the street and the entire area of the old building. All of the eight girders, weighing together 300 tons, were sent in one



SPECIAL STEEL DOUBLE YOKE AND METHOD OF CLAMPING IT TO GIRDER

shipment on a lighter from the bridge shop on Staten Island to the foot of Fifteenth Street, East River, New York City, and thence transported in one day about 1 mi. to the site, on a special truck drawn by thirty-six horses. At the site the girders were unloaded by the derrick, which was about 237 ft. above the curb.

In handling the girders special steel double yokes were clamped to the girder on opposite sides of the center of gravity and pin-connected to the derrick hoisting tackle. A manila tagline was attached to each end of each girder to keep it clear of the front of the building. These lines were operated by hand and snubbed to keep them always taut.

After the first girder was hoisted and set, work was stopped on account of rain. The next day five girders were set, while the remaining two were placed two days later. The eight girders were hoisted and set in about twelve hours' actual working time, the last one being hoisted and set in twelve minutes.

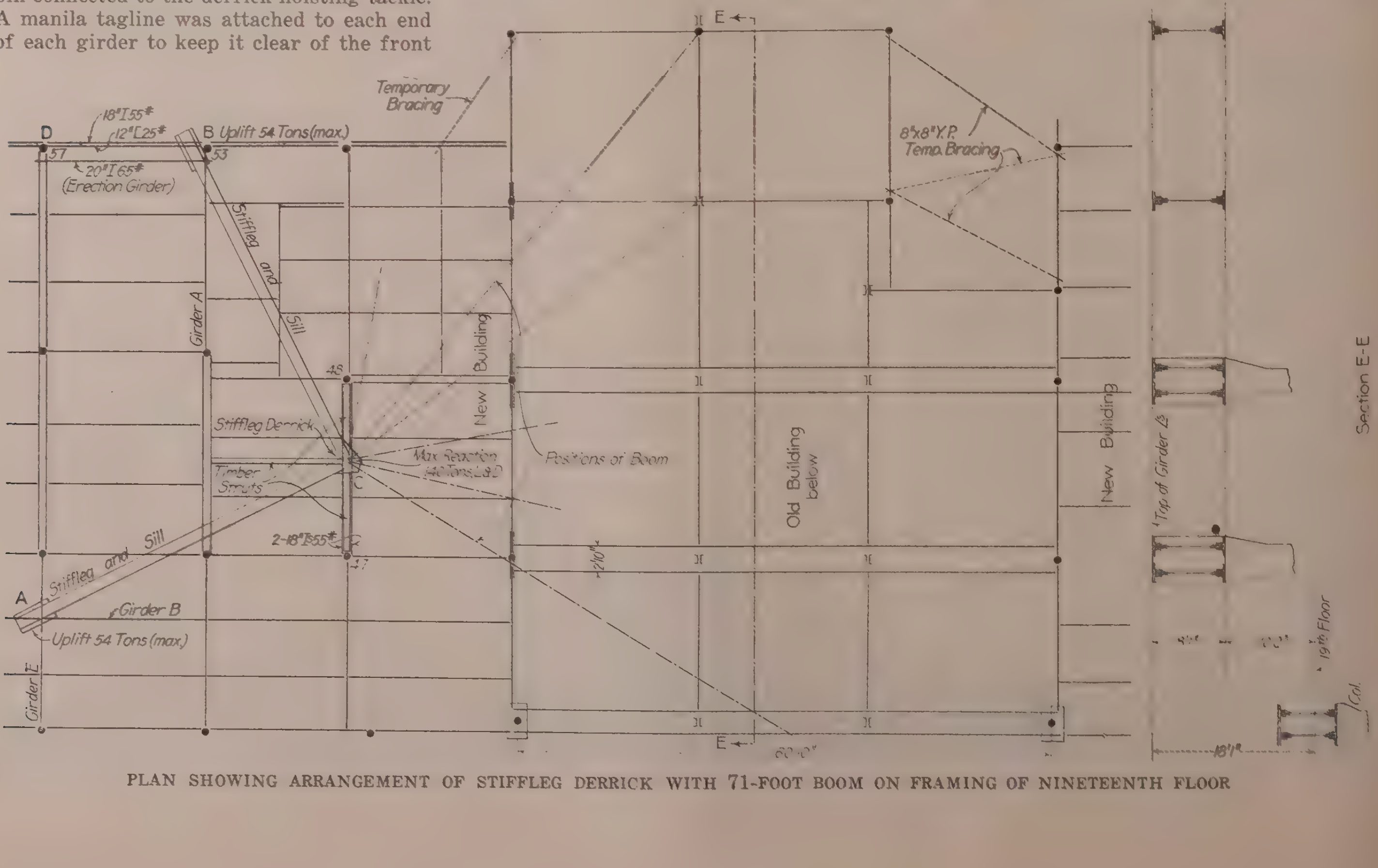
After hoisting, the girders were landed on shelf angles provided on the large gusset plates at the tops of the columns, and were service-bolted in position to secure them until the field rivets could be conveniently driven. The erection was accomplished without accident and without noticeable vibration or evidence of distress in derrick or building. Although the unsupported tops of the columns which received the girders projected 18 ft. above the upper floors, their alignment and accuracy were such that no manipulation was required to make up the connections between columns and girders.

DERRICK INSTALLATION, OPERATION AND SUPPORTS

The derrick, whose capacity was 80 tons, weighed 45 tons, and was rigged with a thirteen-part hoisting tackle, rove with a ⅝-in. plowsteel cable and a nine-part topping lift of 1-in. cable. The hoisting cable was 4000 ft. long and was wound on an extra large drum of the 12-in. Lidgerwood double-drum hoisting engine installed on the eighteenth floor. At the beginning of the hoisting of the 40-ton girders, the steam pressure registered 90 lb., but soon dropped to 60 lb., which was maintained throughout the hoisting period. Under maximum load the derrick reactions were 140 tons at the foot of the mast and 54 tons uplift at the feet of the stiffiegs.

The derrick was operated with a flat boom for unloading and storing the girders, and was boomed out 62 ft. for hoisting. The derrick mast was supported midway between columns on the regular floor-beams, which were reinforced by a wooden A-frame and shores, distributing the load through the lower floors. The stiffiegs were anchored to the framework near the columns with sufficient connections for the heavy uplift.

The derrick sills and the foot of the mast were connected to an irregular horizontal base plate about 4 ft. wide and 4 ft. long, through which the maximum vertical load

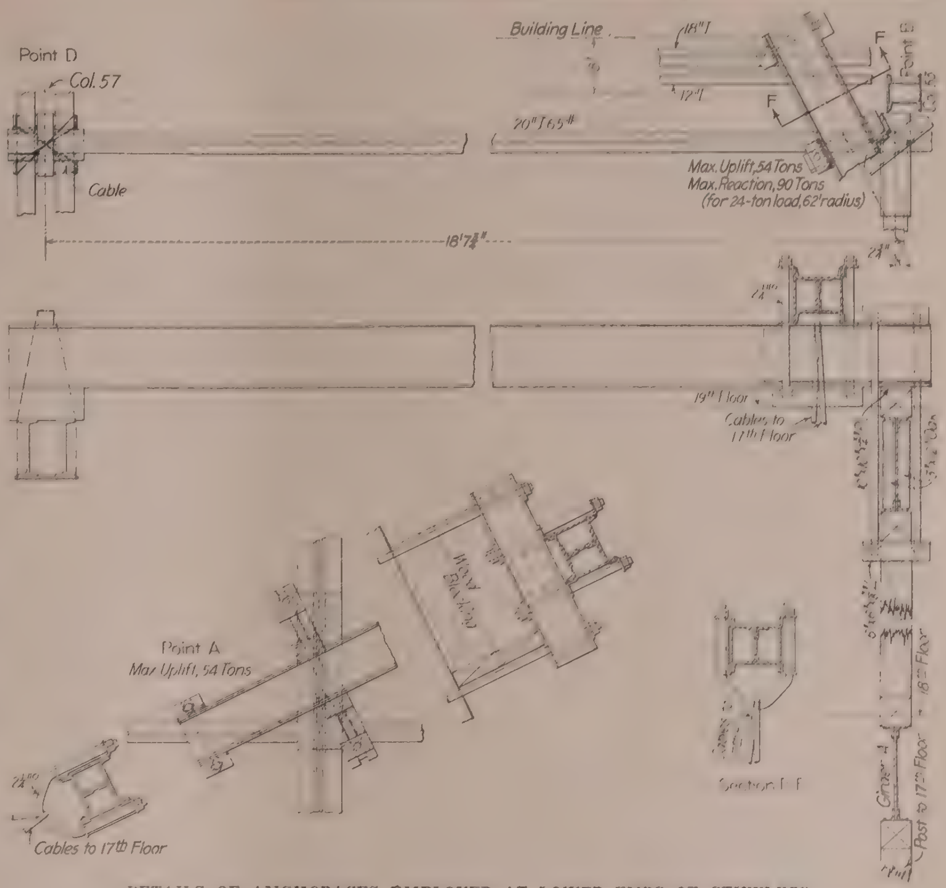


PLAN SHOWING ARRANGEMENT OF STIFFLEG DERRICK WITH 71-FOOT BOOM ON FRAMING OF NINETEENTH FLOOR of 140 tons was transmitted to a 6 x 5½-ft. grillage, made of two tiers of 12 x 12-in. timbers supported on a temporary wooden A-frame that in turn rested on vertical wooden shores, distributing the load through the seventeenth, sixteenth and fifteenth floors without transmitting any of it directly to the eighteenth floor.

The 122,000-lb. horizontal component of the stresses in the inclined posts of the A-frames was taken by six parts of 1¼-in. cables provided with turnbuckle adjustments and engaging eyebolts passing through the vertical flanges of the bearing angles. This arrangement served to give an extended base to the derrick support, to distribute the load through fixed connections and to stiffen the steel framework against erection stresses and vibration.

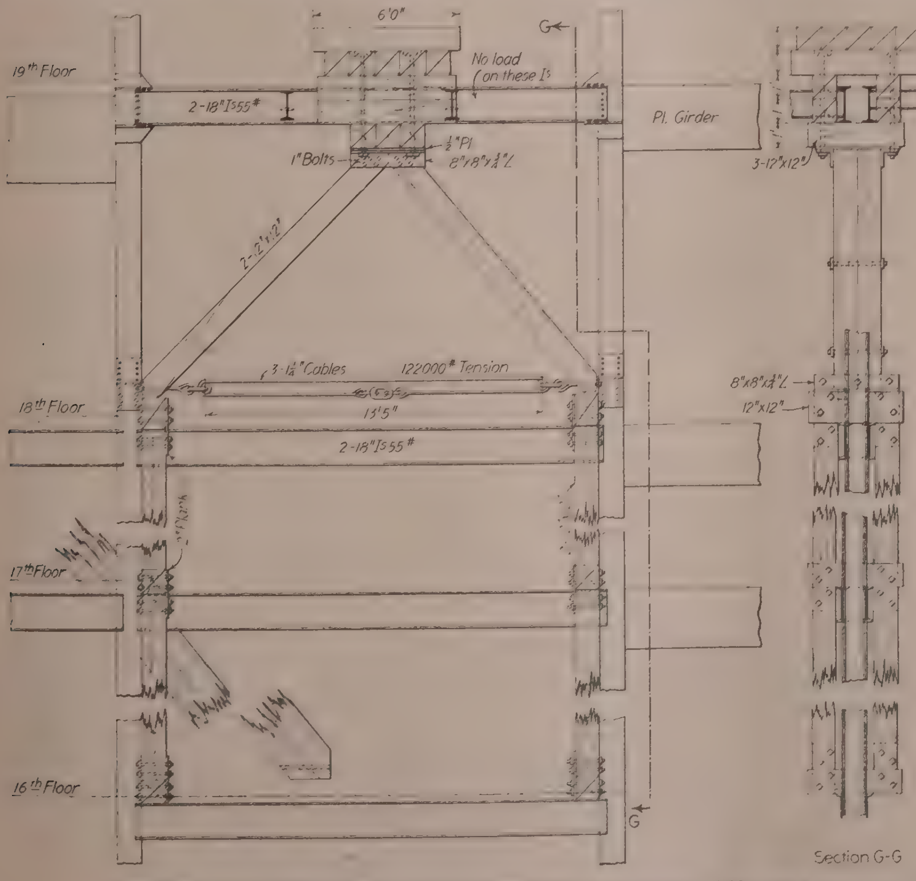
ANCHORAGE AND STIFFLEGS

The lower ends of the stifflegs of the main derrick were pin-connected to sills made of two channels with horizontal webs, latticed and reinforced at the connection by a vertical web or diaphragm. Both sills were anchored at their stiffleg connections to the permanent framework, with connections designed to resist the 54-ton uplift. One of them was supported on the wall girders at point *B*, and on an erection girder made of a temporary 20-in. I-beam resting on and transverse to permanent interior girder *A*. The sill was connected to the erection girder and to the wall girders by four 2¼-in vertical screw rods with double nuts which engaged the top flanges of the sill and yoke angles bearing on the bottom flanges of the girders.



DETAILS OF ANCHORAGES EMPLOYED AT LOWER ENDS OF STIFFLEGS

The erection girder was secured to the interior girder by a similar yoke screwed tight against wooden bearing pieces. Positive load at this point was provided for by a vertical shore supporting the bottom flange of the transverse girder, and wedged to bearing on the floorbeams of the seventeenth and eighteenth floors. The opposite end of the erection girder rested on the top flanges of a pair of permanent interior girders transverse to it, and was secured to them by lashing with a steel cable. The erection girder was also anchored, at its connection with the derrick sill, by vertical steel cables passing between the vertical connection rods and attached to one of the permanent steel columns below its eighteenth-floor connections.



TEMPORARY WOODEN A-FRAME FOR SUPPORTING A LOAD OF 140 TONS

The other stiffleg was anchored at point *A* by a yoke with four vertical screw rods with double-nut bearings, two of them on the top flanges of the sill, and two on a pair of yoke beams resting on the top flanges of the supporting permanent beams and girders. One of the rods through the girder sill had double lower nuts bearing on the bottom flanges of the yoke girders, and all of the other rods had double bottom nuts bearing on saddle pieces crossing the bottom flanges of the permanent beams and girders. The end of the sill projected beyond the yoke connection and was additionally anchored by cables connected to two of the permanent columns below the seventeenth-story floor beams. The upper ends of the cables engaged a vertical U-bolt passing through the flanges of the sill and having double nuts with bearing on the top flange.

HOISTING YOKE FOR 40-TON GIRDERS

The 40-ton girders were connected to the hoisting tackle by a double yoke concentric with the center of gravity. This yoke had two pairs of vertical screw rods just clearing the girder flanges, and provided with double top and bottom nuts. The bottom nuts took bearing on the lower flanges of saddle beams made of two channels riveted together back to back, with space between the webs to receive the rods. The upper flanges of the channels engaged oak cushion slabs countersunk to clear the rivet heads in the bottom flanges of the girders.

The upper nuts took bearing on similar saddle beams, with their lower flanges seated on the top flanges of a balance beam 9½ ft. long, made of two channels riveted together back to back, with clearance between their vertical webs for the vertical rods. An oak cushion block similar to that on the bottom flange of the girder was interposed between its top flange and the beam. The pair of double connection plates was riveted to the inner faces of the channel webs and was pin-connected to a link made of two pairs of rolled plates riveted together with a 5¼-in. separator at the center, and bored at both ends to receive pins connected to the balance beam and to the tackle of the hoist.

The building was designed by and erected under the supervision of the engineering department of the Consolidated Gas Company, of New York, of which William H. Bradley is chief engineer and W. Cullen Morris, engineer of construction. The foundations and steelwork were designed by Herbert W. Alrich, assistant engineer of construction. The structural work was fabricated and erected by Milliken Brothers, Inc. The Geo. A. Fuller Company was the general contractor for the entire building. The field work was directed by C. L. Pierson for the Fuller Company, H. A. Colvin for Milliken Brothers, Inc., and A. W. Stark for the gas company.

A Plea for Greater Mileage

Abstract of Paper Read at Fourth American Road Congress at Atlanta by S. Percy Hooker, State Superintendent of Highways of New Hampshire

ASSUMING that $25,000 is available for laying 10 mi. of road—partly through low unditched muck land, partly through rolling gravel, or partly deep sand or clay or rock—what design will you adopt? This question was asked in an address delivered at the Fourth American Road Congress, held in Atlanta, Ga., Nov. 9-14, 1914, by S. Percy Hooker, State Superintendent of Highways of New Hampshire. His discussion of the question has been abstracted in this article.

Most road departments with standardized plans would be content with a small stretch of expensive road. I believe this is a serious economic error. In most sections a road infinitely better than those existing may be built at a comparatively small cost to the great betterment of the roads in general and to the great help of the inhabitants of the State.

Having designed alignment, grade, drainage and foundation for the road assumed, what shall be used for surfacing? In many places you will find adjacent to the road hills or hummocks which contain soil not properly either hardpan or clay, but a combination of each, containing considerable metal in the shape of either pebbles or fractured stone. Apply 10 in. of this and by the use of road drags and road hones bring it first into section and next into a smooth hard surfacing. This will prove satisfactory in all weather for traffic, provided it has constant attention and is dragged after every rain with the ordinary road drag. The drag moves every slight rut which may be started and does not allow the water to settle through the weak upper surfacing. The maintenance must be not intermittent, but constant. You may find that you still have a somewhat slippery upper surface, in which case it will be necessary to add an inch or two of gravel or sand. This will only require from 3 to 6 yd. of gravel surfacing per 100 ft. and, while it may be at a considerable distance from the improvement, it will not add materially to the cost.

Surfacing Costs

Such surfacing will require practically 2000 yd. per mile, and if the material is from different banks along the roads the cost will not exceed 20 cents per yard. It is then perfectly feasible over this section to build such a highway, including the raising of the grade from 1 to 2 ft. at a cost of not more than $2500 per mile. In rocky sections of the assumed road the design of the maximum grade may determine the method of keeping the cost to the required figure. Where deep sand is encountered a sand-clay road should be built. I have had poor success with these unless the sub-base has been practically telfordized.

For a ledge-and-boulder section far from the railroad or stock pile macadam is the feasible surface; a local crusher should be installed. As water is usually hard to get under such conditions, it may be advisable to bituminize the surface, but this will greatly increase the cost. For metal 15 ft. wide 2600 tons of stone per mile will be required. The use of 2¼ gal. of bitumen per square yard will make the cost more than $2000 per mile. If water is fairly convenient, you may build the waterbound road and apply ½ gal. per square yard of bitumen as a cover coat for about $650 per mile. Unless there is considerable trouble about getting water, therefore, I should recommend the use of waterbound macadam with the blanket coat.

My experience is that a patrolman with a horse and cart, an efficient drag or hone and the willingness to work will keep in almost perfect condition from 5 to 7 mi. of cheaply constructed roadway for from $175 to $200 per mile. Given the same mileage of the higher types of road he will require a helper, a much larger equipment and, if working on bituminous roads, probably not less than $150 per mile for material in the way of bitumen, crushed stone, etc.

The average cost of maintenance on the higher types of road, including the use of a blanket treatment once in two years, will not be less than $500 per mile, and in many instances it will greatly exceed this. On the expensive road you are also constantly facing the fact that within a reasonable number of years you must resurface at a cost of $6000 a mile, while on the cheaper road, if properly patroled, you will find that the surface material is thicker than it was at the time the road was built and that it has been in practically perfect condition during the entire period.

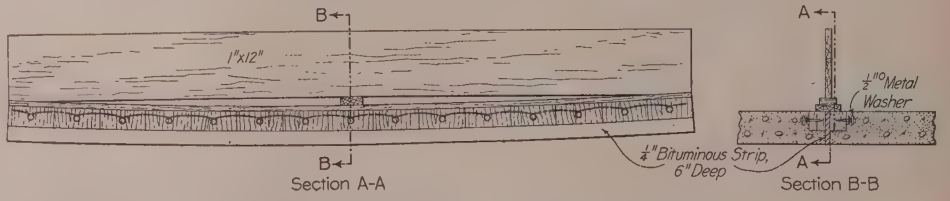
The combination of a very small assessment roll and a large road mileage has made the foregoing system a necessity in New Hampshire. In order to accommodate a large tourist traffic we must have reasonably good roads and we cannot afford the types that are being built in many of the richer States. It seems to me that there are many other States which might well adopt a plan of more mileage at less cost, to their great financial benefit and to the comparative satisfaction of their residents and visitors.

Wood-Block Expansion Joint for Concrete Alley Pavements

Built-Up Strip Used in Baltimore to Protect Joints of Concrete Slabs in Narrow Roadways

CONCRETE pavements have been laid on about ten alleys in residential districts of Baltimore by the Municipal Paving Commission. The need for a joint filler that would provide for longitudinal movement of the slabs and at the same time give the maximum protection for the joints led the engineers of the commission to devise a strip made up of two courses of wood block separated by an asphaltic layer.

The alley pavements are drained at the center and consequently the surface is dished. The accompanying sections indicate the details of the joints. Into the outer side of each 8 x 3 x 3½-in. block is fixed a 3 x ¼-in. lag-screw projecting outward about 1 in. The blocks are wired together with two lines of 12-gage annealed wire twisted over the screws. After the bituminous strips, ¼ x 6 in., have been placed between the two courses of blocks, a 1 x 4-in. plank is nailed to their tops over the full width, and to this is attached vertically a 1 x 12-in. plank. The large plank serves as a handle or grip with which the joint may be held in place while concrete is brought under and flush with the block. The required concavity is furnished by the insertion of a small block between the form planks.



SECTIONS OF WOOD-BLOCK EXPANSION JOINT, WITH INSTALLATION TIMBERS

It is stated that this rather elaborate joint has fully justified itself by the service given. It is as flexible as any and has the further merit of protecting the concrete edge with the wooden block instead of the soft asphaltic strip. The connecting or lag-screws, of course, bond with the concrete and hold the wood surface true.

Joints at 30-ft. intervals are generally used on the concrete alley pavements and a 1 : 2 : 4 concrete mix is specified. The device was suggested by F. K. Duncan, office engineer of the Municipal Paving Commission, and was perfected with the assistance of other engineers in the department, of which R. Keith Compton is chairman.

Pollution of the Great Lakes by matter discharged from vessels is becoming a serious menace to health, according to the annual report of Surgeon-General Rupert Blue of the U. S. Public Health Service. About 16,000,000 passengers are carried over the Great Lakes each year. Evidently, according to Dr. Blue, the inland vessels play an important role in the maintenance of a high typhoid rate.

Reinforced-Concrete Highway Arch for Grade Separation

Abutment Yardage Materially Decreased by Placing Bent of Girder Span Directly Over Skewback to Distribute Loads

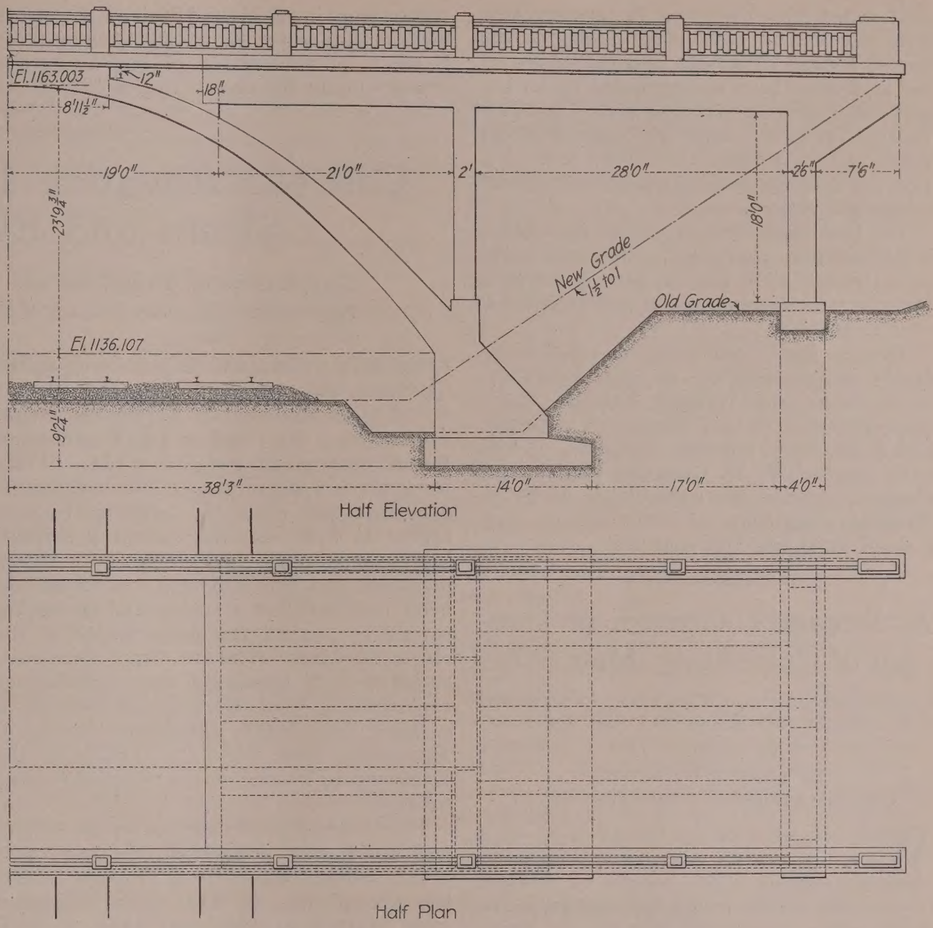
At the crossing of the relocated main line of the Delaware, Lackawanna & Western Railroad with a highway 1 mi. east of New Milford, Pa., a reinforced-concrete arched viaduct carries the road across the tracks. The length of the bridge is 160 ft. and its width between parapets 24 ft. As the difference in elevation between the top of rail and the crown of the highway was about 29 ft., an arch of 76.5 ft. free span with a rise of 23 ft. 9¾ in., could be used. Since the arch did not rest on rock, the abutments would have been large in order to distribute the loads. To lessen the inclination of the line of thrust with the vertical, and thus reduce the yardage required in the abutments, the viaduct was designed so that the intermediate supporting bent of girder spans on either end came at the skewback of the arch. Thus the load on the foundation is the resultant of the arch reaction and the vertical load from the bent. This arrangement is shown in the drawing herewith.

ASSUMED LOADS

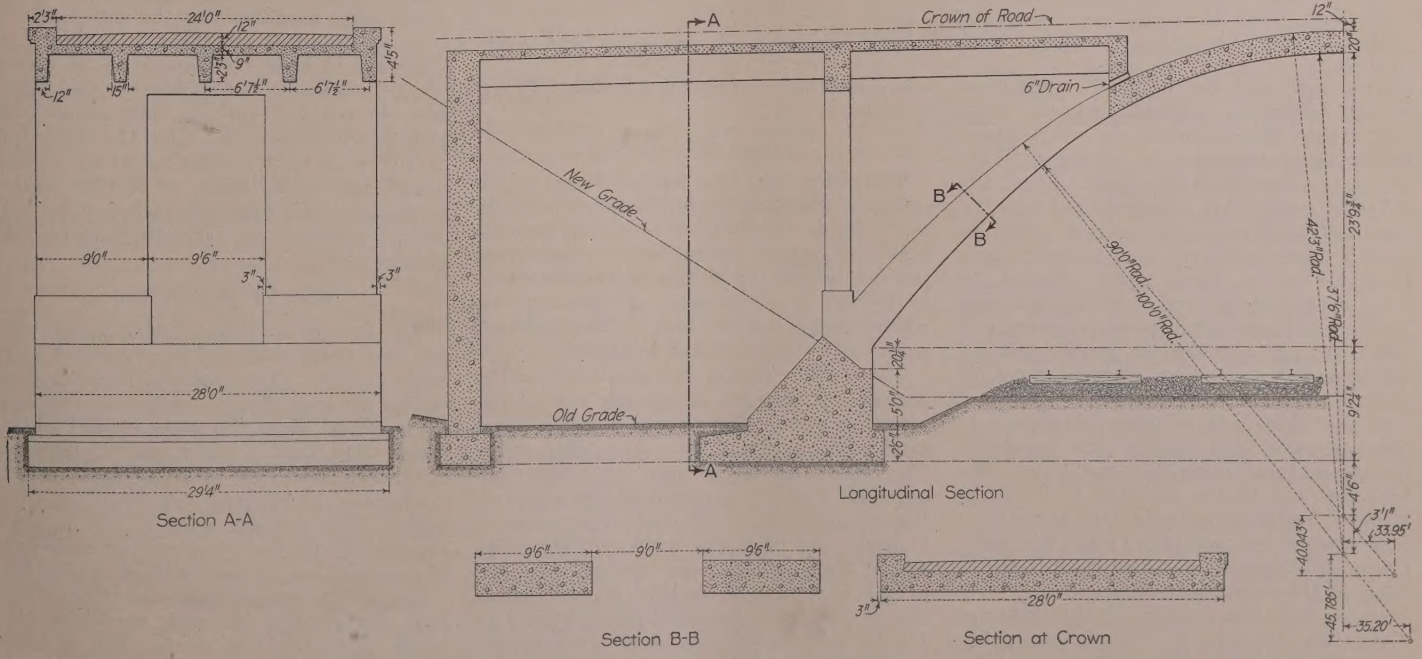
Both a live load of 125 lb. per square foot uniformly distributed over the roadway, and the concentrated wheel loads from a 15-ton road-roller were assumed separately in making the design. The arch carries the floor directly for a distance of 35 ft. The adjacent girder spans are 21 ft. in the clear. One end is supported on the arch, while the other is anchored to bents consisting of two 2 x 9-ft. columns. The outer spans have a free length of 28 ft., and are supported at their outboard ends on bents of three 2.5 x 2.5-ft. columns. The floor slab is 9 in. thick and is supported on five beams. In the calculations of the floor slab it was assumed that the concentrated loads were distributed by the pavement and the concrete slab over a distance of 1.5 ft. normal to the span. The floor was figured as a series of T-beams.

As shown in the accompanying drawing, the arch consists of two rings, each 9.5 ft. wide, spaced 9 ft. clear apart. At the crown these rings have been connected and carry the fill for the roadway directly. The arch ring was designed for three conditions of loading—the dead load only, live load over the entire span plus the dead load, and live load over half the span plus the dead load. The first ring considered was a segment of a circle, and when analyzed for these loadings with their concentrations at the crown of the arch and at the skewback, it was found that the pressure lines in part were very close to the edge of the ring. Then with the pressure lines approximately determined the arch ring was proportioned around them resulting in a curve approximating a parabola. For the uniform loadings the pressure lines were everywhere within the middle third, and there was only a very slight deviation from it for the eccentric loading. A small amount of reinforcement provided for the tension.

Expansion joints for the girder spans have been provided at the supports on the arch, where pockets are formed. To pre-



HALF ELEVATION AND PLAN OF OVERHEAD CROSSING AT NEW MILFORD



SECTIONAL ELEVATION AND DETAILS OF ARCH FLOOR SYSTEM AND BENTS, SHOWING REINFORCED-CONCRETE DESIGN vent water from collecting in these pockets 6-in. tile drains have been placed at the lowest points. The slab and the crown of the arch have been waterproofed by an impervious membrane covered with a concrete finish 1 in. thick. Both the concrete girder spans and the roadway have been built on a 1.38 per cent up-grade toward the midpoint of the viaduct.

The maximum loading of the foundation is 3.5 tons per square foot. The permissible unit stresses were 650 lb. per square inch for concrete in compression and 16,000 for steel in tension.

The viaduct was designed in the engineering department of the Delaware, Lackawanna and Western Railroad under the supervision of G. J. Ray, chief engineer, and A. B. Cohen, concrete engineer. It was built by the W. H. Gahagan Contracting Company, under the supervision of F. L. Wheaton, engineer of construction, and L. G. Krause, resident engineer.

A Decade's Change in Output of Cementing Materials

Comparative Figures of Production for Structural Purposes in 1903 and in 1913, and Value of Same in Latter Year

By EDWIN C. ECKEL

Consulting Engineer, Washington, D. C.

WHILE engaged in the revision of a volume dealing with cementing materials in general, it has become of interest to note the growth which has taken place in these industries during the decade which has elapsed since the first edition of the book was published. A few of the more striking facts developed in the course of these comparisons have been summarized in the accompanying table.

In all cases the data used are based on the figures published by the U. S. Geological Survey. For our present purposes, however, these figures need, in some cases, either rearrangement or revision. This necessity arises from two facts. First, the different cementing materials are sold by very different measures, and in order to make a direct comparison we must calculate them all on the same basis. Second, in many cases a large portion of the total output is used for non-structural purposes, and when we are considering merely the cementing materials these portions must be deducted.

In the tables both of these corrections or changes have been made. The quantities are given, in all cases, in short tons. The tonnages and values assigned to lime and plasters include only those used structurally, so far as it is possible to make this separation, omitting the portions used as fertilizers, in the chemical trade, etc.

In the first two columns of the table are given the tonnages of various cementing materials produced during 1903 and 1913 respectively in the United States. The facts may be of greater significance commercially when the percentages of increase or decrease during the decade are calculated, as has been done in the third column. The last column gives the total value of the 1913 output, excluding that not used for structural purposes.

OUTPUT OF CEMENTING MATERIALS IN 1903 AND IN 1913, PERCENTAGE INCREASE OR DECREASE, AND VALUE IN LATTER YEAR

Class of material	1903 output, tons	1913 output, tons	Increase, per cent	Value of 1913 output
Portland cement	4,244,600	17,498,430	312	$92,557,617
Gypsum plasters	952,543	1,980,157	108	6,908,785
Building lime	1,000,000	1,358,099	36	6,011,856
Magnesia	47,208	183,570	289	3,212,475
Natural cement	931,510	98,667	*89	345,889
Puzzolan cement	78,962	17,707	*78	97,663
Total	7,254,823	21,136,630	†191	$109,134,285

*Decrease. †Average.

Cost of Excavating Drainage Ditches with Steam and Electric Machines

Comparisons of Drag-Line and Suction Dredges Operated on the North Side Minidoka Project of the United States Reclamation Service

THERE is now under construction on the North Side Minidoka irrigation project of the U. S. Reclamation Service an irrigation system, described in the Engineering Record of April 25, 1914, page 468. In this work use is made of both steam and electric machines, and while the latter were much higher in first cost, the operating expense has been so much lower than with steam machines that this handicap has not merely been overcome, but a substantial saving recorded as against the performance of the steam machines. The two types were compared by F. N. Cronholm, superintendent of construction, U. S. Reclamation Service, in a paper read before the Idaho Society of Engineers, from which the article in the Engineering Record, above referred to, was taken.

Five dredges are in service on the project and are rapidly completing the work that is now thought necessary to properly control the ground water. Two steam machines were started in 1910 and 1911, a small suction dredge was started early last spring, and on Sept. 1 two electric machines commenced work. Besides this equipment, small contracts are let to farmers, who perform the work by means of teams and fresnos, these contracts being mostly small jobs where it is not found economical to use machinery.

STEAM MACHINES

The steam drag-line machines are of the ordinary standard type and were built on the project. They have revolving frames, rope-swing, 1-yd. bucket and a reach from the center bearing to the end of the boom of 58 ft. The machine is mounted on rollers supported on planks. The approximate cost of the machine is $5,000.

The suction dredge was also built on the project. It consists of a boiler and an engine direct-connected to an 8-in. centrifugal sand pump, mounted on a 10 x 30-ft. scow. The 40-ft. discharge pipe is counterbalanced by a weight suspended from a pole on the opposite side of the boat. The material is discharged back of a levee built along the line of the proposed construction. The end of the suction pipe is kept on the center line of the drain, for by digging from 1 to 1½ ft. below grade the sandy soils slough in to approximate 1½ :1 slopes and have the required bottom width. The machine is moved forward or backward and held in position by means of light cable controlled by drums operated by hand. The total cost of the machine was approximately $2,500.

ELECTRIC MACHINES

The two electric dragline outfits are Class 9½ Bucyrus machines, of the most modern type, having gear swing and caterpillar traction. The total reach of the machine when the boom is in digging position is 54 ft. The bucket is of 1¼-cu. yd. capacity, made by the Page Engineering Company. It is like the buckets used on the steam machines except that it has a chain in place of a stiff bail.

The caterpillar feature is a decided advantage as compared to rollers and greased skids. The data secured since the machines started show a saving of 5 per cent of the digging time, besides eliminating the services of at least one man. The desirable features of the caterpillar are that the machine can be propelled in either direction, will go over very soft or rough ground, and may be turned in the length of the machine. The cost of each machine complete was approximately $13,800.

The wisdom of purchasing these electric machines rather than the steam machines may be questioned when considering the high price of the former; but when the field cost per cubic yard is compared we find a saving of 56 per cent in favor of the electric machines. Had there been less than 200,000 cu. yd. for each machine to move, the purchase of such high-priced machines would not have been justified, because the difference in cost of moving the 200,000 cu. yd. would only have equaled the difference in cost of the two machines. Inasmuch as there are at least 100,000 cu. yd. in excess of this amount, a saving equal to the difference in cost of moving this amount, or $5,000, will be effected, plus the difference in the value of the two machines at the completion of the work, or at least $5,000 more, making a total net saving of $10,000 on the purchase of each machine on this project alone.

COST OF EXCAVATION

The cost of moving 675,000 cu. yd. with the two steam machines has averaged 13.22 cents to date. This cost is for work done on two different drains. Although each machine moved about the same amount of material, they worked under entirely different conditions, resulting in an average for one machine of 11.06 cents, and the other 15.13 cents. The detailed cost of the average yardage for the two machines per cubic yard of cross-section yardage is shown in Table 1.

In order to compare the cost of the steam and electrically operated machines, the lower cost, or 11.06 cents, will be used. The details are presented in Table 2.

TABLE 1—DETAILED COSTS, PER CUBIC YARD, OF EXCAVATING WITH THE TWO STEAM MACHINES

Labor excavation	$0.0434
Hauling and pumping water	0.0123
Hauling and handling coal	0.0066
Coal, including freight	0.0252
Repairs, labor	0.0017
Repairs, material	0.0051
Cables	0.0034
Carbide	0.0013
Miscellaneous supplies	0.0049
Depreciation in machinery	0.0111
Engineering and administration (15 per cent)	0.0172
Total	$0.1322

TABLE. 2—DETAILS OF LOWER UNIT COST FOR STEAM MACHINES

Labor excavation	$0.0360
Hauling and pumping water	0.0102
Hauling and handling coal	0.0048
Coal, including freight	0.0212
Repairs labor	0.0015
Repairs material	0.0037
Cables	0.0027
Carbide	0.0010
Miscellaneous supplies	0.0040
Depreciation on machinery	0.0112
Engineering and administration (15 per cent)	0.0143
Total	$0.1106

The average cost for the first two months' operation of the two electric machines was 7.1 cents. Even though the operators were inexperienced at first with this type of machine, and the conditions were slightly more difficult, a saving of 36 per cent has resulted, the comparison being made on the total cost, which includes depreciation and engineering and administration. Aside from engineering and administration and depreciation, a comparison of the costs shows a saving of 56 per cent in favor of the electric machines. The details are shown in Table 3.

TABLE 3—DETAILED COSTS FOR TWO ELECTRIC MACHINES

Labor excavation	$0.0204
Electricity, at 1 cent per kw	0.0045
Repairs, labor	0.0001
Repairs, material	0.0004
Steel rope	0.0011
Transmission line, at 6 cents per foot	0.0078
Miscellaneous supplies	0.0035
Depreciation on machinery	0.0240
Engineering and administration (15 per cent)	0.0092
Total	$0.0710

Table 4 shows a comparison of the detailed cost in a condensed form.

TABLE 4—COMPARISON OF COSTS FOR STEAM AND ELECTRIC MACHINES

Detail	Steam machine	Electric machine	Saving
Labor	$0.036	$0.0204	$0.0156
Power	0.0372	0.0123	0.0249
Miscellaneous	0.0119	0.0051	0.0068
Depreciation	0.0112	0.0240	......
Engineering	0.0143	0.0092	......
Totals	$0.1106	$0.0710	$0.0483

Depreciation and engineering and administration are based on costs and yardages. Further, the steam machine has depreciation figured at 1 cent per cubic yard and the electric at 2 cents, and, therefore, these items cannot be compared on the two machines.

The average amount of electric power per cubic yard of cross-section yardage has been 0.45 kw. since the two machines started. The average amount of coal per cubic yard of actual yardage was 7.4 lb., or 8.1 lb. for the cross-section yardage. When working under exceptionally good conditions in easy digging the pounds of coal per cubic yard should not exceed four; yet, this depends largely on the size of the boiler. Before the boilers on the steam machines were replaced with others of 35 per cent greater capacity, the average amount of coal per cubic yard was 10 lb. From this will be seen at a glance the importance of large boiler capacity.

TRANSMISSION LINE AND SUCTION DREDGE

The cost per station of drain for line construction was $5.95 for one machine and $6.08 for the other, the detailed costs of the latter being shown in Table 5.

TABLE 5—COST OF ONE TRANSMISSION LINE

		Total cost	Cost per mile	Salvage per cent	Chargeable to drain
Labor, total line construction		$280.98	$93.66	.00	$280.98
Material					
Poles, 12 pc. 30 ft.	$28.92				
Poles, 74 pc. 25 ft.	158.36				
		187.28	65.76	80	39.46
Wire, 12000 lb. No. 1 copper		2,034.14	678.05	90	203.41
Cross-arms and 100 pins		38.00	12.67	80	7.60
Cross-arm braces (150)		16.50	5.50	80	3.30
Insulators		14.08	4.69	80	2.86
Pins, bolts, anchors, etc.		42.18	14.06	80	8.43
Labor, tearing down (estimated)		....	....	..	175.00
		$2,623.16	$874.39		$721.00

Note: Total chargeable to drain, $721.00; total line constructed, 3.0 miles; total length of line available for drain construction, 120 sta.; line depreciation per station of completed drain, $6.08; salvage value of line, based on completed drain, 72 per cent.

The detailed costs on the suction dredge per cubic yard of cross-section yardage on 100,000 cu. yd. to November, 1913, are given in Table 6.

TABLE 6—DETAILED COSTS, PER CUBIC YARD, FOR SUCTION DREDGE

Labor excavation	$0.0567
Hauling and handling coal	0.0040
Coal, including freight	0.0161
Repairs, labor	0.0027
Repairs, material	0.0030
Cables	0.0004
Carbide	0.0007
Levee construction	0.0086
Miscellaneous supplies	0.0062
Depreciation on machinery	0.0200
Engineering and administration	0.0178
Total	$0.1362

Condensing this detail, the same as was done with the detail of the electric and steam machines, we have the following:

Labor	$0.0567
Power	0.0201
Miscellaneous	0.0216
Depreciation	0.0200
Engineering	0.0178
Total	$0.1362

In addition to keeping detail cost per cubic yard of the different machines, a record is also kept of machine efficiency, which shows the percentage of digging time and various delays, such as moving, repairs, coating, etc. The actual yardage, as well as the cross-section yardage, is also computed in order to determine the percentage of excess yardage, and in this way hold the operators nearer the required section.

ROADS IN COOK COUNTY, ILLINOIS, outside of the corporate limits of the various villages, aggregate in length 1325 mi. Of these, 325 mi. of the main thoroughfares have been designated as State-aid roads, to be constructed with a permanent pavement. The remaining 1000 mi. must be repaired and maintained at the joint expense of the township and the county. According to the new State law the county can, under certain conditions, aid in their construction to the extent of 25 per cent.

Pipe Subways for the Public Utilities of Chicago

Abstract of Report to Commission on Downtown Municipal Improvements by Louis A. Dumond, Secretary-Engineer

FOLLOWING a European inspection trip to view the methods employed abroad to care for underground public utilities, Louis A. Dumond, secretary-engineer of the Chicago Commission on Downtown Municipal Improvements, presented a report of his findings and has drawn conclusions which are given here nearly in full:

From an engineering standpoint pipe subways, when properly constructed and operated, are practicable as a means of carrying all public utilities, including gas. They prevent pavement mutilation and reduce to a minimum the cost of maintaining utility services. Their great first cost has so far prevented their use except in cases of emergency or in the construction of new streets.

To install pipe subways in Chicago many difficulties will have to be overcome which may be classified under the heads of legal, financial and construction. It must be determined whether the city can compel the companies to occupy pipe subways if constructed. To accomplish this special legislation will probably be necessary, which will enable the city to compel utility companies occupying space in the city streets, under franchises granted by the city, to occupy galleries or subways constructed for the purpose of housing such utilities whenever the City Council shall deem that the congestion of utility services in a given street justifies the construction of such galleries or subways.

RENTAL OF PIPE SUBWAYS

From the financial standpoint there must be provided the first cost of such construction. While there may be some debate as to who should pay for utility galleries it seems probable that the city would have to pay this cost. It may be possible to show that the rental obtained from the use of such galleries would pay the interest upon the cost of construction. The fairest system of rental would be one based upon the estimated saving to the companies of placing their services in galleries. The city would have to support and maintain the services now in the streets during construction. New services should, in most instances, be installed in the subways after completion.

If the preliminary difficulties above outlined can be overcome the installation of a system of pipe subways in the central business section should be seriously considered by the City Council. The city should determine through its law department to what extent, if any, the subsidewalk space may be recovered and used for the location of public utility services. The subsidewalk space being excavated forms the most economical location for a pipe gallery. If it were found possible to use this space to any extent, the first cost of a system of utility galleries might be considerably reduced.

Utility galleries should be built in connection with all transportation subway improvements in the central business district as a part of such subways if possible. Otherwise they should be built at the same time and financed separately. The privilege granted in the future to any company to occupy the streets of the city should contain a proviso that it shall remove or transfer its conduits, or other property, into any subway or other structure the city may in the future build or provide, and the company pay a rate per annum for the use of the same.

NEW ENGINEERING STAFF SUGGESTED

The city should establish within the department of public works a department of underground structures modeled after the board of highway supervisors in Philadelphia. This department would include the duties now performed by the bureau of permits and in addition work up a system of accurate records of underground structures, which would be of inestimable value not only to the city but to the companies themselves. The commission should endeavor to obtain an appropriation sufficient to employ an engineer of authority, together with an office force, to give a more intensive study to the points herewith outlined and also whether it would not be possible and economical without interfering with future subways to construct a new system of main sewers of such size as to carry the mains of a high-pressure water system and possibly such other services as could be accommodated. The possibilities of utilizing the Illinois Tunnel as a utility gallery should be carefully considered.

In the report are noted methods of locating public utility mains under pavements, beneath the sidewalks, in large sewers and in pipe subways. Of the first method, that followed in all American cities and in most English cities, Mr. Dumond concludes that the only way to insure that the damage done to pavements by public utility companies will be properly repaired is for the city to do the work itself.

In Germany and to a great extent in Austria and France the subsidewalk space is utilized for all but the main sewer which is usually located beneath the pavements. That this regulation insures good pavements is attested to by Mr. Dumond in describing its workings in Munich, Dresden, and Berlin. Paris is famous for the use of its sewers as conduit carriers with the exception of gas mains, which are buried under the sidewalks, as in the street near the curb. Opinion of foreign engineers seemed to be divided as to the advisability of placing gas mains near electrical conduits, either in the ground or in galleries.

LONDON'S UNDERGROUND STRUCTURES

London's pipe subways, the method of financing and maintaining them and rates charged were elaborated upon by Mr. Dumond. In the Victoria Embankment pipe galleries which were stated to be the most congested of any of the London subways, the total cross-sectional area of services is about 17.7 sq. ft. If 20 sq. ft. be taken as an indication of what may be expected in the downtown streets of Chicago, the cross-sectional area would have to be made greater than that of the Victoria Embankment gallery, which is 9 ft. wide by 7 ft. 6 in. high. If galleries were constructed either above or below a transportation subway and made the full width of the subway, providing sufficient headroom for a man to work, the amount of space furnished would always greatly exceed the minimum requirements. In such a wide gallery it would be possible to segregate certain services such as gas or high-pressure water, should it be desirable, by means of compartments. In galleries located in duplicate in a street, either in connection with or independent of a system of transportation subways, it would be desirable to make the gallery much larger than actually required to handle the services. With galleries in the subsidewalk space such an opportunity is offered.

Invariably the comment on the London subways and on those of other cities visited was to the effect that pavements are in excellent condition and usually are never torn up after their construction. In London no explosions have ever occurred, and the authorities do not consider the practice of carrying large gas mains in the same gallery as in any way dangerous, but all pipe subways are inspected daily and any leaks are followed by a notice to make immediate repairs.

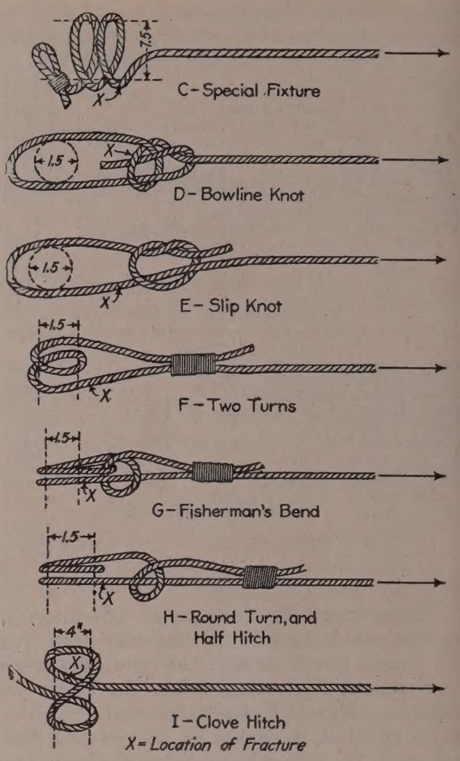
Manila Rope Fastenings

Tests of Tensile Strength of Common Hitches Indicate That Eye-Splices Are Most Satisfactory Considering High Strength They Develop

TESTS to destruction of nine ordinary methods of fastening manila rope were made in 1913 at the U. S. Arsenal, Watertown, Mass., and developed tensile strength varying from 4140 to 9350 lb. per square inch. Twenty-two tests were made on three-strand manila rope with a diameter of about 0.85 in. and a circumference of 2.68 in. The length of the pieces between the knots or ends of splices was generally 18 in. except for two specimens *I*, where it was 42 in., and for specimens *A* and *B*, which were both 11 in. In addition to fourteen fastenings of the types illustrated there were four fastenings *A*, consisting of an eye-splice with two tucks on each strand, and four fastenings *B*, with eye-splices of the same character except that for the first two tucks the full section of the strand was used, for the third tuck about one-third of the section was cut away, and for the fourth tuck another third was cut away, thus producing a splice which tapered gradually to the diameter of the rope between the splices.

The breaking loads for the different fastenings are shown in the accompanying table.

In tests 7, 8, 9, 13, 14 and 15 the rope slipped continuously until rupture occurred. In test 16 it slipped so that it was necessary to reseize the end three or four times, which took about 2 hr. after the load was applied for the first time. The results of the tests were plotted, and from a study of the diagram it was concluded that eye-splices are the most satisfactory considering the high strength which they develop in the specimen. Their cost also is not excessive when compared with many of the fastenings which require much more rope to make. Even with the eye splices the full strength of the rope is not developed, as shown by the fact that the fracture almost always occurs at the inside end of the splice. Possibly not more than 95 per cent of the strength is developed in most cases. The weakness of these fastenings appears to be caused by the low strength of rope at small radius bends.



LOCATION OF FRACTURE OF DIFFERENT FASTENINGS

CRATER LAKE NATIONAL PARK in Oregon is to have a system of good highways built by the Government. This year about 20 mi. of the system were built, according to the statement of the engineers who came out about Nov. 1 and reported a most successful season. A total of about 40 mi. of highways has now been constructed. George E. Goodwin is the engineer in charge.

BREAKING LOADS FOR DIFFERENT ROPE FASTENINGS

Number	Kind of fastening	Length required for two fastenings Ft.	In.	Time to make two fastenings Min.	Tensile strength Total Lb.	Per sq. in. Lb.	Parted
1	A	3	9	15	4,920	8,670	1 strand at end of splice.
2	A	3	9	15	4,550	8,020	1 strand at end of splice.
3	A	3	9	15	4,500	7,940	1 strand at end of splice.
4	B	4	0	35 to 40	5,200	9,170	1 strand at end of splice.
5	B	4	0	35 to 40	4,200	7,400	1 strand at end of splice.
6	B	4	0	35 to 40	4,910	8,640	1 strand at end of splice.
7	C	11	0	5	3,225	5,690	2 strands in the fixture.
8	C	11	0	5	3,080	5,430	2 strands in the fixture.
9	C	11	0	5	3,120	5,500	2 strands in the fixture.
10	D	6	0	4	2,400	4,230	1 strand at short bend.
11	D	6	0	4	2,090	3,680	1 strand at short bend.
12	D	6	0	4	2,270	4,000	2 strands at short bend.
13	E	5	0	3 to 5	3,380	5,960	1 strand at the bight.
14	E	5	0	3 to 5	3,060	5,400	1 strand at the pin.
15	E	5	0	3 to 5	2,856	5,030	2 strands at the pin.
16	F	5	0	...	2,346	4,140	2 strands at the pin.
17	G	7	0	15 to 20	2,448	4,310	1 strand at the bight.
18	H	7	0	10 to 15	2,856	5,040	2 strands at the bight.
19	I	8	0	3	3,600	6,350	1 strand at the bight.
20	A	4	0	15	4,720	8,520	1 strand at the splice.
21	B	4	0	35 to 40	5,180	9,350	1 strand at the splice.
22	I	6	0	3	3,700	6,680	1 strand at the bight.